ENGINEERING NEWS

THE ANNUAL CONVENTION of the American Society of Civil Engineers is now likely to be fixed for some time near the end of June, regardless of the party of Members who sail for Europe on the *City of New York*, May 29. That party will not be very large, consisting of about 25 Members, and numbering 74 in all, including ladies, children and Juniors and Associates. The Mechanical and Mining Engineers, however, send large delegations. If a suitable boat can be chartered, the convention may be held on a Sound or Hudson river steamboat, taking about four days to a trip up and down the Hudson, Long Island Sound and New York harbor.

THE NICARAGUA CANAL CO. will send out an expedition about May 10 to start work on the Greytown pier or deflecting dyke, required to divert the littoral current which has nearly ruined the harbor. It will be built at first of brush and piles, and four pile-drivers are sent down with crews to work them. A diamond drill plant will be sent down likewise, to fully test the nature of the rock in the great cut, and a dredge, after the pier is well started, to open the harbor for construction purposes to 16 or 18 ft. The bulk of the pier will be made of rock from the great cut. It looks as if, before many weeks, work on the canal would be well under way.

THE MUTUAL INSURANCE ASSOCIATION, conducted by the Baltimore & Ohio company for the benefit of its employés, is said to be again creating dissatisfaction. According to report, the compulsory feature is the point objected to by the men, who have threatened a strike at some points on the Western division. It is also said that the rates have been raised, and the payments for accidents and injuries lowered. Officers of the company charge that the dissatisfaction has been fomented by agents of life and accident insurance companies.

Mr. M. N. FORNEY has tendered his resignation of the office of Secretary of the Master Car Builders' Association by a letter printed in another column, and the resignation has been accepted by the Executive Committee. Mr. FORNEY has been Secretary of the Association since 1882, and has contributed greatly to the usefulness and success of the organization. Official announcement has not yet been made of Mr. FORNEY's successor, but it is generally understood that the choice of the Executive Committee has fallen on Mr. JOHN W. CLOUD, if he will accept the position.

RAILWAY BUILDING IN SOUTH CAROLINA is likely to receive quite an impetus from a decision of the Supreme Court of the State which settles finally the disputed question as to whether the bonds voted in aid of railway construction by various townships were valid. The last Legislature passed an act validating the bonds already issued and conferring on the townships the right to vote further bond issues; and the Supreme Court now decides that this act was constitutional and effective.

THE CANADIAN PACIFIC RAILWAY, despite its northerly latitude, seems to have got the better of the snow problem. The total detentions of the winter have been but *seven hours* and the snow-sheds and split and glance fences have so far "filled the bill" perfectly, despite some heavy avalanches in the Selkirks, which must always be expected, and are now amply provided for. The "split and glance fences" referred to, which we have fully illustrated and described (Jan. 21, 1888) are a device new to engineering for controlling avalanches, and, it is now clear, are a very good device. They were devised by General Manager (now President) W. C. VAN HORNE, and their utility was at first much questioned.

PROGRESS ON THE FORTH BRIDGE is reported as follows by Gen. HUTCHINSON for the quarter ending Feb. 25:—South Queensferry bottom members built out 514 ft. and 550 ft. for south and north cantilevers respectively, and riveted for 490 ft. and 410 ft. Inch-Garvie Pier: cantilevers built out 514 ft. and 480 ft. and riveted for 476 ft. and 460 ft. on bottom members. North Queensferry: bottom members built out 514 ft. and 470 ft. and riveted for 500 ft. and 390 ft. The total riveted steel-work at South Queensferry amounts to 12,300 tons, at Inch Garvie to 14,200 tons, and at North Queensferry to 12,500 tons, a total of 39,000 tons, and an addition of 5,000 tons in the quarter. The average number of men employed per day was 3,250.

A NEW CAISSON for the Chicago Lake tunnel is being built of wood. The old iron caisson, that grounded on its way out to the lake-end of the tunnel last year, has been broken up after about $10,000 had been expended in vain efforts to get it afloat. The failure in that one is said to have cost the contractors about $30,000.

THE EAMES VACUUM BRAKE CO. have removed their general offices from Boston to New York, apparently with the purpose of pushing the introduction of their automatic vacuum brake more actively than heretofore.

THE IMPROVEMENT OF ROADS in Massachusetts was recommended by Gov. AMES in his last message, and as a consequence of this suggestion a bill has been drawn up, and is now pending, appointing a Commissioner of Roads and Bridges.

A HUDSON RIVER TUNNEL mortgage for £550,000, or about $2,750,000, was filed in the Register's office of Hudson Co. this week. It is made out to the Farmers' Loan & Trust Co., as a first mortgage, in compliance with the terms of the English syndicate for the construction of this tunnel.

THE TOPEKA ELECTRIC RAILWAY, put into operation last week, cost $600,000, and is 16½ miles long. This system exceeds the electric railway in Richmond, Va., by 4½ miles. While a speed of 15 miles per hour can be easily attained, the law of Topeka limits it to 8 miles.

THE ILLINOIS & MICHIGAN CANAL is to be widened and deepened to the dimensions of a ship-canal if a bill passed at Springfield on April 11 is carried out. It will connect Lake Michigan and the Mississippi river.

WORK ON THE NEEDLES BRIDGE, at the crossing of the Atlantic & Pacific R. R. over the Colorado river, is reported as being temporarily suspended. The cause is stated to be an error in sounding for one of the piers by the company's expert, who reported a nest of bowlders as solid rock. The Phœnix Bridge Co., the contractors for the work, will have to go 60 ft. deeper than originally intended, and a new contract is insisted upon.

THE READING RAILROAD CO., it is said, has finally decided to build a new bridge across the Schuylkill river, in Philadelphia, just below the present Falls bridge. The purpose of this new crossing is to facilitate the handling of the Baltimore & Ohio traffic to New York by the way of the Reading R. R.'s leased lines.

A GREAT WELL, 32 ins. in diam. by 120 ft. deep, has been bored near Mayhew Station, Cal., on the property of R. D. STEPHENS. The work was done by M. R. ROSE, of the Capital Iron Works, Sacramento. It is said to be the largest bored well in California, and to furnish more water than any other in the State. Water from it would rise above the top of the ground were it not for a bed of gravel 10 or 15 ft. thick, some 20 ft. below the surface, through which the water flows off, necessitating pumping. A centrifugal pump, driven by a 60 H. P. engine, is now used to raise the water.

THE MISSOURI RIVER is being surveyed by Government engineers. One party is at work between Bismarck, Dak., and Leavenworth, Kan. Another party will survey from Bismarck north to Fort Benton, Mont.

THE CHICAGO DRAINAGE BILL passed the Legislature at Springfield on April 11 by a vote of 90 to 40. It has yet to pass the Senate and the Governor. This is the open channel project by way of Joliet.

THE PROJECTED FRENCH SHIP CANAL, from Bordeaux, on the Atlantic, to Norbonne, on the Mediterrannean, would be 330 miles long, and have a depth of 27 ft. The estimated cost is $130,000,000, and it would save a journey of 700 miles around Spain. As yet there seems to be little more prospect of its immediate construction than in the day of FRANCIS I, when it was originally projected.

THE MANCHESTER SHIP CANAL is nearly one-third done, as far as the excavation is concerned, says Mr. WALKER, the Engineer. The same authority values the plant at nearly $3,000,000. By June 1, 20,000 men will be at work upon it.

NATURAL GAS has been found in New South Wales near Narrabeen, while boring for coal. The hole is 2,000 ft. deep, and the gas issues in spite of a pressure of 800 lbs. per sq. in., due to the water column. There is already talk of a pipe-line to Sydney, etc

THE INTERSTATE RAILWAY ASSOCIATION is beginning to wrestle with some of the difficulties which it was freely predicted at the outset would finally result in the Associations' disruption. The fast trains between Chicago and Kansas City furnish the ground for a serious quarrel between the Wabash and the Alton managers. Gen. MCNULTA claims that a differential must be allowed the Wabash or else (which amounts to the same thing) that the fast trains must run only Pullman cars in which all passengers will be charged an extra rate. The matter has been laid over until each side can present statistics in support of its position, which will be done before the board of arbitration on April 23. On the same date will be considered the request of the Chicago, St. Paul, Minneapolis & Omaha to be allowed to make the same rate between Omaha and Northern Nebraska points to Duluth as is made from the same points to Chicago. On the following day the disagreement concerning the proposed 10 cent rate on lumber from Chicago to southwestern Missouri points will be discussed. Another matter which has seriously disturbed the general harmony is the announcement that the Chicago, Milwaukee & St. Paul has made a contract with P. D. ARMOUR & Co., running 5 years, by which they agreed to give ARMOUR & Co. 1 cent per mile on all their refrigerator cars run over the Milwaukee system. A uniform rate of ½ of a cent per mile was agreed on last January and now all the roads will be obliged to meet the St. Paul's figures. The fact that ARMOUR is a prominent director of the Chicago, Milwaukee & St. Paul is made the text for very unfavorable comment.

LANDSLIDES have occurred on the Elk Garden branch of the West Virginia Central and the Colorado Midland roads. A slide occurred April 8 on the Chesapeake & Ohio canal about 40 miles east of Cumberland, Md., blocking navigation.——The break in the Erie canal near Lockport, N. Y., is being repaired. Division-Superintendent SERVOSS and Assistant-Superintendent GEORGE CHAMBERS, of Buffalo, and Resident Engineer JOHN BISGOOD, of Rochester, with several assistants, have charge of the work.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head collision April 9 between two passenger trains on the Atlantic & Pacific near Beach Springs, Ariz. The trains were both double-headers, and they met at a curve on a high bank; the engines and some of the cars went over the bank. One man was killed and another seriously injured.——A singular accident occurred near Belleville, Ill., April 14: the track of the Cairo Short Line crosses over a coal mine, and the earth sunk about 10 ft. under a freight train, causing a bad wreck in which two men were seriously injured.——A sleeping car on the Pennsylvania caught fire one day last week, but nobody was hurt. The accident is attributed to overheating of the steam pipes.——A collision between a wild freight train and a mixed train, occurred on the Delaware & Hudson, near Lake Champlain, April 15. The accident occurred on a trestle and one engine went into the lake, the driver being killed.

BRIDGE ACCIDENTS are reported as follows: a bridge on the Atlantic & Pacific, near Lavic, Cal., was burned April 9, and caused the wreck of a freight train.——At Canadian, Tex., the Canadian river has washed away a highway bridge and damaged the railway bridge.

THE NECESSITY OF BLOCK SIGNALS for crowded traffic, as well as of keeping trespassers off the track, was again illustrated this week by a tail collision between a local and following express on the New York & Harlem track, the first train having been delayed by the accident of killing a woman walking on the track. No flagman was either ordered back or went back, and the delay was only short, but it was enough. The collision was quite forcible, but fortunately the rear car was empty. Theoretically

the blame may be laid on the employés: the real fault lies in the system of trusting only to a man's thoughtfulness in emergencies and not making his action compulsory.

THE INTERSTATE COMMERCE COMMISSION has announced a hearing on the subject of free passes and free transportation for May 3, and summons for attendance thereon have been sent to the principal New England and Middle States railways. A hearing on the payment of ticket commissions is set for May 7, and the principal roads between Chicago and Missouri river points and those of Indiana and Michigan are summoned to attend. On the following day the same companies will be heard on the matter of trackage and car mileage.

WE continue to receive occasional communications in regard to forms of keeping level notes, but the subject seems to us to have been sufficiently discussed.

The Pumping Machinery on the City of Paris.

While the *City of Paris* embodies in its construction many novel features and some departures from previous marine practice, none has attracted more general attention in England than the fact that she and her sister ship, the *City of New York* are both fitted out completely with the well-known Worthington duplex pumps.

In all English practice hitherto, the boiler feed pumps have been a part of the main engine, and worked from levers connected directly therewith. Their action has been more or less unsteady, and the strain brought upon the pumps directly, and to some extent upon the engine, has been such as to bring about at times, results more or less disastrous.

So long ago as 1884, when the *America*, constructed by the builders of the *Paris* and *New York*, Messrs. Thompson, of Clyde Bank, Glasgow, and the *Oregon*, built by the well-known firm of John Elder & Co., of Glasgow, both left New York on the same day; much interest was developed in the trial of speed, which all initiated knew would follow. The *Oregon* made Fastnet Light first, beating the time of the *America* by only five hours; but the *America* lost twelve hours by the breaking of one of her pumps which occurred by the racing of the engine. This is liable to occur on any steamer and all steamers where the pumps are a part of the engine.

The *City of Paris* as well as the *City of New York* and also the *City of Berlin* are equipped throughout with Worthington pumps, and the main boiler feed pumps on each of them are independent of the main engines. As each of these ships are furnished with triple expansion engines, and carry a constant boiler pressure of from 150 to 160 lbs. to the square inch, and in the case of the two former ships, develop upwards of 20,000 indicated H. P., the boilers are large and it becomes a necessity to reheat the feed water to a temperature of from 275 to 320° Fahr. This is accomplished by taking the water first from the hot well to a closed heater in which a live steam jet is introduced directly from the boilers and the water reheated. Thence it is pumped directly to the boilers. Both pumps are controlled by a device which regulates their speed to the available supply of water in the hot well, which is not at all times constant.

The quiet, uniform motion of the Worthington pumps can be appreciated perhaps better in this service than in almost any other in which they have been placed. The reports of the engineers of the *Paris* are to the effect that in the rough weather incident to her first stormy voyage across the Atlantic, when at times it became necessary to slow down the main engines on account of racing, the pumps named kept on the uniform tenor of their way, and required little or no attention at the hands of the engineering staff. This fact was appreciated at the time and will be appreciated by all engineers who have passed any time in the engine room of an Atlantic liner.

There are sixteen Worthington pumps on the *Paris*, the same number on the *New York*, and nine on the *Berlin*.

The White Star steamers *Teutonic* and *Majestic*, now fitting out at Belfast, are both equipped with Worthington pumps.

The Repairing of Betchworth Tunnel, Dorking, on the London, Brighton and South Coast Railway.*

The Betchworth Tunnel, on the direct Portsmouth line of the London, Brighton & South Coast Railway, is about ¼ mile south of that company's Dorking station, in the Lower Greensand formation, 136 ft. at its maximum depth under Deepdene Park.

The tunnel is straight, 385 yds. in length, and has a rising gradient of 1 in 80 southwards towards Holmwood. It was originally designed with slightly curved side walls 1 ft. 10½ ins. thick, and with a segmental arch of similar thickness, and, except for a length of 12 ft. near the north face, an invert was dispensed with.

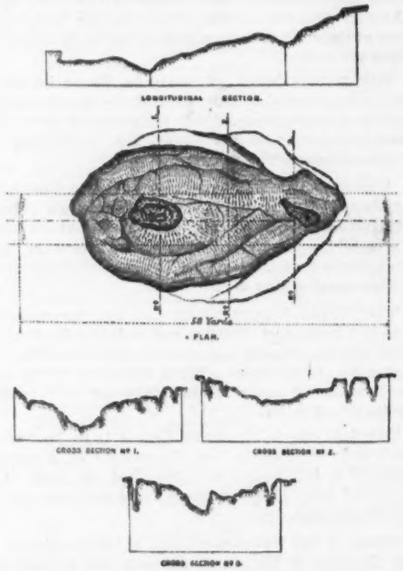


Fig. 1. Plan and Cross-Sections of Break in Betchworth Tunnel.

In the northern portion of the tunnel the green sand is quite hard, in some places approaching rock, presenting a straight and solid face, and needing but the merest skin of brickwork lining to secure its retention in place; but gradually this changes to sand mixed with boulder stone, which again gives place to sand pure and simple, of the finest quality, wholly dry, and devoid of the least cohesion. Indeed, with the exception of a portion about 25 yds. long, 40 yds. from the north entrance, no water was found.

The original tunnel was opened for public traffic in May, 1867, and formed the most important work on the Horsham and Dorking section of the railway.

During the 20 years that had elapsed since the construction of the tunnel until the collapse, on July 27, 1887, when, without warning, a portion of it fell in, only ordinary superficial repairs of decayed bricks were necessary or were made. In fact, repairs of this character were in progress in a portion of a tunnel when the collapse occurred; but no kind of doubt had been entertained of the perfect security of the work, as it exhibited throughout every sign of stability and solidity. The sudden failure is all the more surprising as the summer had been exceptionally dry, and in that part of the tunnel no repairs were, or had been, in hand. A failure was first suspected at about 5 P. M. on that day by a foreman of plate-layers, who noticed that the brickwork at about 70 yds. from the south end was badly cracked, and appeared to be giving way, a fine stream of dry sand coming through the fissure; the fracture extended longitudinally, at a height of about 12 ft. above rail-level.

At the time this was noticed a train from Horsham was due, and having waited to see it through the tunnel, the man, observing that the crack was increasing, at once ran out towards Dorking station and stopped a "down" train which was about to enter; on his return, the tunnel was wholly blocked.

Early on July 28 the tunnel was visited by the Chief Engineer, accompanied by the General Manager of the railway and the author. From the north end up to the stoppage, the brickwork appeared sound and intact; but here the tunnel, from rails to soffit, was completely filled with fine dry sand, which had been probably driven down by the weight of the superincumbent mass from the surface of the park above, and had extended far beyond the place where the collapse had occurred. The merest cracks could be perceived in the soffit at the crown, close to the sand. On examining the ground above the tunnel, a depression, extending for 45 yds., and varying in width from 10 yds. to 27 yds., and at its deepest part 21 ft., was found (Fig. 1). The south end was then visited, and it was apparent that the dry sand had run in as through a funnel, choking the line for a length of 58 yds., and filling every crevice until a slope of about 2 to 1 at both ends was formed. Rather clearer signs of settlement in the soffit were visible, but practically the sand hid everything, and the full extent of the failure could only be surmised.

The result of this inspection was a prompt decision to tunnel through the slip in a right line, and make good the work from below, the execution being entrusted to Mr. J. T. FIRBANK, as contractor, and the author being appointed Resident Engineer.

Both north and south of the slip the arch showed signs of weakness, and the first thing undertaken was shoring it against falling in. Six elm skeleton ribs were fixed under the arch at both places, tightly wedged and supported on sills and struts, carried down into the solid ground and to the level of the foundations of the side walls.

To do this, a trench about 2 ft. wide was sunk through the slip, from the soffit of the old arch to the foundations, the end nearest the slip and the side being close-poled with 3-in. deals, and stretched to the walls; the polings were liberally packed with hay to stop any of the sand running. Then 12-in. by 6-in. timbers were laid, and 9-in. by 9-in. props placed upon them, on which a top sill, 12-ins. by 6-ins., was put, and these received the skeleton ribs. Between the ribs and the soffit, laggings, about 2 ft. apart, were run in and tightly fixed against the arch by page-wedges driven between them and the ribs.

The arches having been thus practically secured,

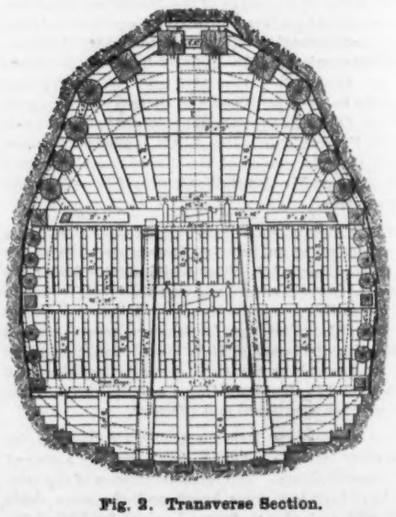


Fig. 2. Transverse Section.

a start was made to close-timber the broken end by poling from the crown. Poling-boards, 2 ins. thick by 3 ft. long, were inserted vertically, and a stretcher, about 6 ft. long by 10 ins. square, was got in about 3 ft. down from the soffit, the ends being carried well behind the old work. The sand was thrown back on the slope, to assist in forming a scaffold, and also as a counterbalance to the more central body of the slip. The poling was then continued, the 10-in. stretcher acting as the waling, and another stretcher was duly inserted 3 ft. lower as before.

In the same manner the face timbering was carried down to the heel of the rib, when it was stopped and a top heading commenced. The bottom waling was previously angle-strutted from the side walls by 12-in. by 12-in. timbers, let into the walls and tightly wedged therein, the other end being birds-mouthed. The top heading, 4 ft. wide

*By George Lopes, Assoc. M. C. E., from selected papers of the Institution of Civil Engineers.

by 6 ft. high, was then cut through the face polings at the level of the soffit, and driven 20 ft. into the slip, at a rising inclination of 24 ins. in its length, and, this point gained, the heading was returned towards the face, rising 24 ins. more, and again returned with another 24 ins. This, allowing 2 ft. 3 ins. for the thickness of the arch, gave 2 ft. for the crown-bars and 1 ft. 9 ins. drop. The heading, close-timbered throughout, was poled at the sides with 1½-in. boards, and on the top with 2-in. boards. The head and side trees were 9 ins. die-square, placed 3 ft. 6 ins. from center to center on 12-in. by 6-in. foot-blocks, each 18 ins. long. The feet of the side trees were stretched across with the same sized timbers, all well dogged with iron "brobs" and laced with long boards 1 in. thick.

When the 20-ft. length of heading was finished, a crown bar of pitch-pine, 2 ft. square and 18 ft. long, was put in position, one end being run back 3 ft. over the crown of the existing arch, and the leading end being supported by a 10-in. square back prop, placed on a foot-block. The heading was widened piecemeal, by removing sitting and close-poling, until room for another bar alongside the first was obtained, great quantities of hay being used all the time, until 5 crown-bars had been fixed and propped.

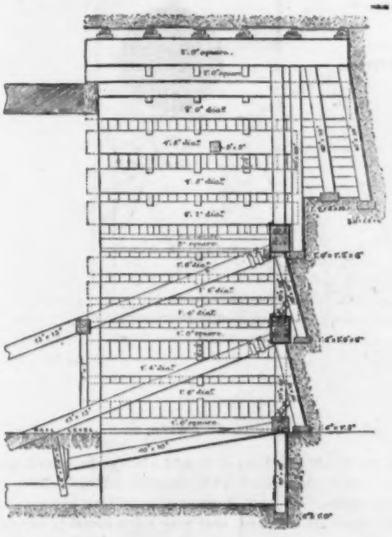


Fig. 3. Longitudinal Section.

A nipper sill, 16 ins. by 8 ins. and 12 ft. long, was then laid in, and the 5 bars were propped again from it. The top heading, in its width, thus disappeared, and mining for a 12-ft. length proceeded, the sides always being close-boarded, and 3 bars on each side inserted until the sill bed-level was reached. The bars, with few exceptions, were of larch. Back props, 10 ins. by 10 ins., were then got in, resting on foot-blocks, the sill of pitch-pine, 16 ins. square, was driven into place, and a wooden saddle, 8 ft. long by 16 ins., was fastened to the upper side.

Each bar was supported over the sill by 10-in. props, radiating with the curve of the arch. Stretchers, 16 ins. square, were fixed between the old brick face and each end of the sill, and angle-struts or judkins raking from the brickwork to about 4 ft. on each side of its center. The two rakers, 46 ft. long, running 7 ft. into the solid ground, with foot-blocks, were fixed and wedged, birds-mouthed at the sill, and with two-wrought-iron glands to each near the upper ends. The rakers were themselves stretched by a 9-in. by 9-in. stretcher near the top end, and by a 12-in. by 12-in. stretcher about halfway down.

The length was then deemed practically secure, and a gullet, about 6 ft. wide, was driven through the loose sand from the face at the middle sill-level, the sides being still close-poled and stretched. The face near the upper sill being gained, three back props, 10 ins. by 12 ins., were got in with foot-blocks to each, and the gullet was widened until the upper sill was supported by 11 back props, all being close-poled, and the sides of the tunnel were reached. Three more bars on each side were then fixed, and the middle sill followed similar to the upper one. Twelve upright props were fixed between the upper and middle sills, and sill-stretchers from the brickwork to the sill ends were put in, and rakers with foot-blocks. A bottom gullet, 6 ft. wide at rail-level, was now driven as before, and 11 back props were got under the middle sill, and close-poled until

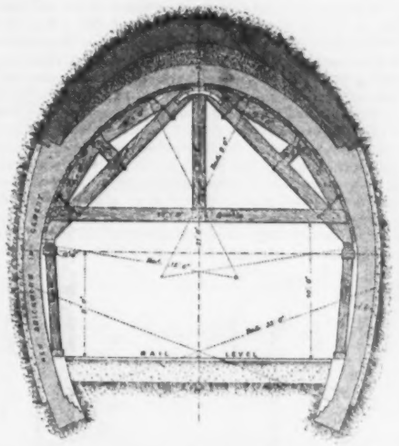


Fig. 4. Segmental Center Supporting Relieving Arch.

the sides were again reached, when two more bars on each side were fixed, The bottom sill, 14 ins. square in one length, was then placed in position, and 11 vertical props, 10 ins. square, were inserted between it and the middle sill, and 12-in. sill-stretchers put in; 10-in. square rakers, with foot-blocks, followed, and the excavation was complete, being fully timbered to the level of the rails.

The mining for the invert was then proceeded with, the face only being timbered; the curve for the invert, being shallow, was not poled.

Between the top bars, 12 in number, short stretchers were fixed about 3 ft. apart, and single stretchers between the rest, a 9-in. cross-stretcher, or cock-roost, running between the fourth set of bars. All props were dogged top and bottom, but no bolts were used, driving and page-wedges, however, being plentiful. The back props were fastened to the sides by 9-in. by 3-in. angle-ties, and the bottom uprights and the lower sills were laced by 1-in. boards.

Figs. 2 and 3 represent the full timbering for a 12-ft. length of inverted section.

The brick work was then put in hand, invert moulds and leading frames being first placed in position. The side stretchers and bars were removed as the brick-work was got up, until the side walls were ready for the skeleton centers. These, three to each 12-ft. length, were made entirely of elm in three thicknesses. The middle center leaves 2½ ins. thick, and the leading centers 3 ins. and grooved, with laggings 7 ins. by 3 ins., were supported on 9-in. props on brick piers 14 ins. square, built out from the invert with 12-in. by 6-in. sills, and placed on beech slack-blocks 18 ins. by 7 ins. by 3½ ins.

As the arch progressed, the side bars were taken out until six crown bars remained, which were built in, and the spaces between them filled in tight with brickwork to the poling-boards. The keying-in for 1 ft. 10 ins. wide was effected by block laggings fixed transversely on grooved laggings specially prepared. These block laggings were 22 ins. long by 7 ins. by 3 ins., notched at each end to fit the grooves, and the key of the arch was made good from one end outwards. The whole of the poling-boards were left in.

This length being thus finished, the mining for another proceeded as the first, and the whole length was executed in precisely the same manner. Another length followed, until three lengths from each end were completed, when a top heading was driven through to connect the two faces. Both faces were kept in hand until an interval of 36 ft. remained, when the north end was stopped and the south only proceeded with. When this length was finished, the north was completed and the junction only was left. Here the bars were supported only on the toothings of the arches on either side, and as the brickwork was finished, eight bars were built in with it, thus 37 yds. were completed.

The skeleton ribs were left standing about ten days, by which time the cement was well set. Notwithstanding, and in spite of the bars being bricked in solid, the excessive weight of the superincumbent sand in the slip broke the toothings at the junction of every length, causing a slight crack, the greatest being ¼ in. wide; these cracks were immediately stopped, and there was no further settlement.

Where the old arches at both faces showed signs of cracking and weakness, which was for a length of 10 yds. at the south end, and 8 yds. at the north end, the inverted section was continued, and here it was built in lengths of 6 ft. The skeleton ribs already fixed were made the base for the work, 12 in. timbers being thrown across from sill to sill with planks over them. An upper scaffold was then made of 3½-in. by ½-in. double irons slung from the sides of the ribs with cross-bolts, upon which die-square timbers were placed and plank-sheeted to enable the miners to start breaking into the key of the old arch.

As the brickwork was cut away, short polings were got in until the 6-ft. length was removed, when a crown bar 12 ins. in diameter, one end resting on the new brickwork, and the other on the old work, was inserted. The mining was continued, bars being put in about 18 ins. apart for the extent of the arch, below which bars of 9 ins. die-square and 2 ft. apart, sufficed, until all the old brickwork in the length had been removed, the face of the sand being close-poled all the while and the end face secured by waling 12 ins. square strutted by 9-in. timbers from the new brick invert. Each 6-ft. length was carried out in the same way, except at the ends where the inverted section was to be abandoned. Here the arches were gradually projected over longitudinally beyond the walls until at the crown they led for about 9 ins. This was to act as a shield to a lower arch.

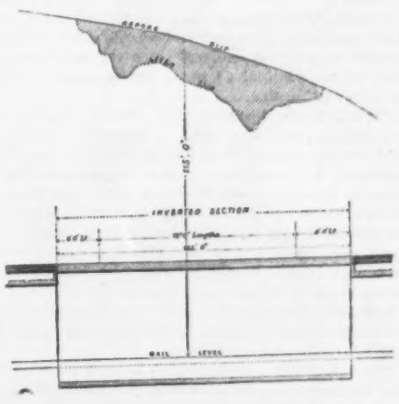


Fig. 5. The Surface Before and After Slip.

The very unsatisfactory character of the old brickwork, thus exposed, suggested a complete examination of the rest of the tunnel, and with hardly an exception the work was found to be defective. Accordingly Sir JOHN FOWLER, K. C. M. G., Past President Inst. C. E., the Consulting Engineer to the Company, was invited to confer with Mr. BANISTER and to determine on the course to be pursued as regarded the remaining 330 yds. of the tunnel.

It was then decided to remove the whole of the side walls, to rebuild them in Portland cement, to turn a relieving arch, also in cement, at a lower level than the old one, and to dispense with an invert. The new side walls, being 18 ins. thick instead of 1 ft. 10½ ins. like the old walls, were backed with cement concrete to the sand, and carried up with the new relieving arch of sufficient thickness to underpin the old arch until the relieving arch was clear of it. The new arch was 18 ins. thick, and the space between the crown and the old soffit was filled in with old dry bricks tightly wedged and packed (Fig. 4).

The work was built in cement throughout and 10 break-ups were put in hand at once, which, as the work proceeded, was found to be the extreme limit for safety. Four skeleton ribs were fixed at each place, the middle ones 9 ft. apart and sheeted with 7-in. by 3-in. laggings, tightly wedged. The level of the underpinning was first ascertained and the

brickwork cut away for 9 ins. thick, when die-square timber was put in and strutted off the ribs, and another 14 ins. got out under that and strutted in like manner. The back being thus reached, the brickwork was gradually removed to the footings, and the sides were close-poled, packed with hay, and strutted by larch bars 12 ft. long, 9 ins. thick and 2 ft. apart, their ends being let into the brickwork on each side.

As soon as the old brickwork had been removed the new was inserted, great care being taken in the underpinning, which was most tedious and difficult, the old brickwork being practically loose, with every tendency to fall. As length after length was executed, the old side walls were in many places splintered and cracked, and more skeleton ribs had to be erected, and the mining lengths reduced from 9 ft. to 7 ft. 6 ins. By this arrangement, however, the work was completed without accident. Where the relieving-arch section joined the new inverted arch (Fig. 5) a wall 14 ins. thick was built as face packing, and at the south entrance the whole of the spandrels and parapet were taken down and rebuilt.

The ribs for the relieving arch were made in two sections of 6-in. timber, the struts raking from crown to heel with cross-ties and queenpost, and could be taken in pieces and reunited. The tie-beams were kept sufficiently high above the rails to leave room for the contractor's six-wheeled locomotive which worked through the tunnel.

The time occupied in the 55 yds. of new inverted section in the slip was from Aug. 8 to Dec. 30, 1887, and in the remaining 330 yds. from Nov. 7, 1887, to Feb. 7, 1888, continuously day and night, with the exception of Christmas Day.

In the reconstruction, one of the two lines of railway through the tunnel was taken up and the other slewed to the center for the convenience of the contractor.

Although there was little water in the tunnel, the long cutting at the south end on a gradient falling towards the tunnel rendered necessary the preservation of the original drainage arrangement, which was by a 12 in. pipe.

During the busiest part of the reconstruction 300 men were employed night and day with six horses and one locomotive. The bricks, of which two and one-third millions were used, were the best Horsham stocks. Cement was supplied by the Sussex Portland Cement Co., Newhaven, to the extent of 780 tons, and this was mixed with 2,000 cu. yds. of sand, part from pits at New Cross, and part from beds at Oxted. Water was at first provided in tanks from Horsham and Holmwood, but afterwards from the main of the Dorking Water Co., by a 2-in. pipe laid through the tunnel with junctions and bib-cocks where necessary.

The following materials were supplied, viz. :—62 elm skeleton ribs; 114 segmental centers; 16,500 cu. ft. of timber; 3,030 cu. ft. of larch; 37,400 lin. ft. of 3-in. by 7-in. battens; 40,600 lin. ft. of 3-in. by 9-in. deals; 52¼ fathoms of poling-boards; 48,700 page, driving, and raking wedges; 760 slack blocks; 10 tons of hay; 10,525 galls. of naphtha, and 3,474 lbs. of candles.

The slip comprised about 33,000 cu. yds., and of this the bars in a 12-ft. length of the inverted section bore 10,500 tons during the mining.

The cost of the work per linear yard of the inverted section was £145, and of the relieving-arch section £30. The exceptionally heavy expense of the former was caused by the enormous quantity of timber necessary to support the slip, and to the necessity of building in so much of it.

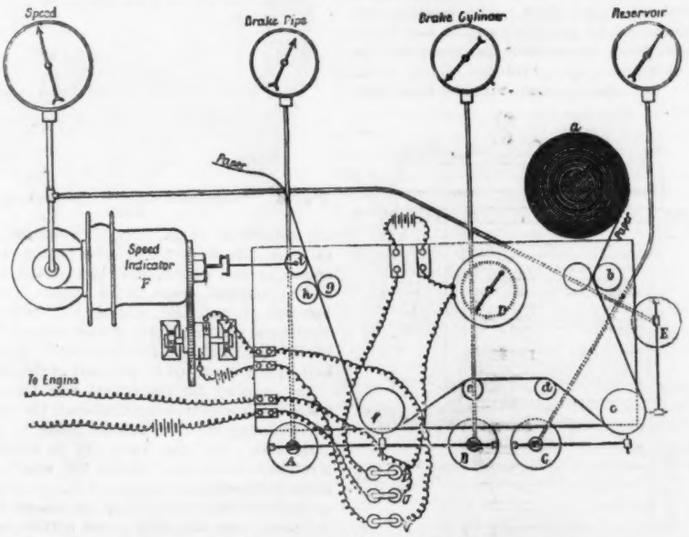
The tunnel was opened for traffic March 1, 1888.

The Sun: Its Heat and Light.

At the monthly meeting of the Royal Meteorological Society, held on March 20, Dr. MARCET delivered an address on the above subject, in which he said that the source or origin of all meteorological phenomena is the sun, which sends or radiates its heat to the earth through the molecular vibration of the invisible matter connecting earth with space. If there were no air or moisture, we should feel the sun's heat to a much greater extent. After the sun's rays have reached the earth, a portion of the heat they bring with them is absorbed by the earth and terrestrial objects, another is converted into motion, and a third is reflected into space.

After describing the various actinometers and other instruments used for determining the amount of solar radiation, Dr. MARCET showed that the temperature of the solar rays falls rapidly when tested at increasing altitudes in a balloon. He then gave an account of some observations made by Mr. GLAISHER in the celebrated balloon ascent which he and Mr. COXWELL made from Wolverhampton on Sept. 5, 1862, when they reached a height of about seven miles above the earth's surface. Regarding the transformation of solar heat into motion, a very interesting illustration is afforded by the radiometer, in which the direct influence of the sun's rays causes a light vane to rotate; while another illustration of the mechanical effects of heat upon fluids is their conversion into what is known as the spheroidal condition.

In connection with this, Dr. MARCET showed how, by wetting his hand, he could pass it through molten lead without injury. He also related the case to HENRY HALL, one of the keepers of the Eddystone Lighthouse, who, on the occasion of the fire which destroyed the lighthouse on December 4, 1755, accidentally swallowed some molten lead, but did not die till several days afterwards, when a piece of lead was taken out of his stomach. Dr. MARCET then briefly drew attention to the sun's light, stating that the passage of the sun's light through our atmosphere alters it in kind to a great and remarkable extent. Light can be decomposed into its elementary colors. In connection with this branch of the subject, Dr. MARCET performed a number of experiments, including, among others, that of passing a ray of light through a glass vessel freed from dust, when the ray disappears within the vessel, but reappears on the other side, showing that the power to form light was there, though not the material for this power to act upon. Dr. MARCET concluded his very interesting address by describing the various forms of sunshine recorders.—*Industries.*



Kapteyn's Recorder; Diagram of Arrangement of Parts.

New German Brake Tests.

Some very interesting brake tests with the new quick-acting Westinghouse apparatus have lately been made at Carlsruhe on the Baden State Railways, which were witnessed by a large number of German, Austrian, Italian, and Swiss railway officials, and excited great interest among them by the "wonderfully" quick action of the brake. In the results of the tests themselves there was nothing especially new; they were simply confirmatory and a repetition of the series of Westinghouse 50 car tests of 1887, which astonished the whole engineering world, and left little room for further effort to break the record, which the Carlsruhe tests have not done, nor even closely approached it. The apparatus used to record the tests, however, which we herewith illustrate, seems to be somewhat of an advance upon past practice, and highly ingenious. For our engravings, and the main facts of the following record, we are indebted to *Engineering*, which was the only journal represented at the tests.

The point which lent especial interest to the German tests, and which is likely to very speedily advance German practice, was the importance from a military point of view of being able to run very long trains of 50 or more carriages, and yet handle them properly. *Engineering* quotes from *The Indian Engineer* to the effect that in India, where the military phase of the question is likewise highly important, "the efficiency of the vacuum brake (the one adopted) was never tested at all on such long trains as those which it is desirable to have available for military purposes"—from which it is an entirely safe prediction that there will be some very unpleasant experiences in the rear cars of such long trains, if it be attempted to run them.

There were three experimental trains, the longest of 50 cars, all fitted throughout with brakes except the truck of the engine, and it was found that the brake was applied on the last car, through a total length of 1,500 ft., within 1¾ seconds from the moment the driver's brake valve was opened. This is about ⅛ second more than the velocity of sound, and by so much less quick than the velocity appeared to be in the Westinghouse 50 freight-car tests above referred to, in which a whistle was blown on the engine simultaneously with the opening of the engineer's brake valve; and standing at the rear car, over 1,700 ft. off, the brakes would always be heard to go on before the sound of the whistle arrived. This latter method of test, however, was less precise than the German method, and may have erred ⅛ second.

The trains experimented with were in detail as follows, train No. 1 being fitted with the old brake gear as well as the new, so that stops under the following different conditions could be made:

a. Ordinary brake with small pipe.
b. Quick-acting brake with small pipe.
c. Quick-acting brake with large pipe.

Trains 2 and 3 had only the quick-acting brake.

Train No. 1*a*. *Length*, 535 *ft.*

		Weight.	Pressure on Brake-Blocks.
		tons.	tons.
1	Locomotive	45	18
1	Tender	27	13
16	Third-class carriages	152	91
1	Saloon	9.9	5.7
1	Experimental van	8.6	2.6
Total..18	Carriages.	242.5	130.3

Train Nos. 1*b and* 1*c*. *Length*, 540 *ft.*

		tons.	tons.
1	Locomotive	45	18
1	Tender	27	11.2
13	Third-class carriages	122.2	73.3
4	Goods vans	37.4	23.8
1	Experimental van	8.6	2.6
Total..18	Carriages	240.2	128.9

Train No 2. *Length*, 870 *ft.*

		tons.	tons.
1	Locomotive	45	18
1	Tender	27	11.2
23	Third-class carriages	216.2	129.7
6	Goods vans	56	34.7
1	Experimental van	8.6	2.6
Total..30	Carriages.	352.8	196.2

Train No. 3. *Length*, 1,545 *ft.*

		tons.	tons.
1	Locomotive	45	18
1	Tender	27	11.2
40	Third-class carriages	376	225.6
9	Goods vans	84.1	53.6
1	Experimental van	8.6	2.6
Total..60	Carriages.	540.7	311.0

The stops were all made on a straight and level track. Speed was taken between a first, second, and third signal, 200 metres (656 ft.) apart. *Engineering* gives the following record taken of the tests, to which we add a column giving the efficiency of the brakes in terms of the per cent. of retarding force to the total weight on braked wheels.

Result of Trials.

Number of Experiment.	Nature of Stop.	Speed of Train.	Distance run after Application of Brake.	Time from Application of Brake to Stop.	Particulars of Trains.	P. c. of efficiency.
		mile per ho	ft.	sec.		
1	Ordinary	44.7	1,174	30	Train No. 1a, ordinary Westinghouse brake, small pipes, 18 carriages.	5.8
2	Emergency.	39.7	507	16		9.8
3	"	43.5	659	17.4		10.1
4	Ordinary.	43.5	1,292	31	Train No. 1b, quick-acting brake, with small pipe, 18 carriages.	4.9
5	Emergency.	39.1	515	15.75		10.4
6	"	44.7	613	17		11.5
7	Ordinary.	44.1	994	25	Train No. 1c, quick-acting brake, with large train pipe, 18 carriages.	6.7
8	Emergency.	38.5	506	15.6		10.3
9	"	43.5	640	18.5		10.4
10	"	48.5	794	21.25		10.4
11	Ordinary.	44.1	1,516	34	Train No. 2, quick-acting brake, large pipes, 30 carriages.	4.2
12	Emergency.	34.8	420	14.25		10.0
13	"	40.4	564	16.7		10.0
14	"	42.2	600	17.5		10.3
15	Ordinary.	34.8	1,538	40.5	Train No. 3, quick-acting brake, large pipes, 30 carriages.	2.4
16	Emergency.	28.6	302	12.5		9.3
17	"	34.8	443	14.8		9.4
18	"	36.0	462	15.5		9.7

In computing the last column of this table, by which alone the results can be intelligently compared, we have assumed (from internal evidence of *Engineering's* record), that the unbraked engine truck weighed 9 tons, and was consequently 3.72 per cent. of the weight of train 1*a*, 3.74 per cent. of train 1*b* and 1*c*, 2.55 per cent. of train 2, and 1.66 per cent. of train 3. The formula for computation is

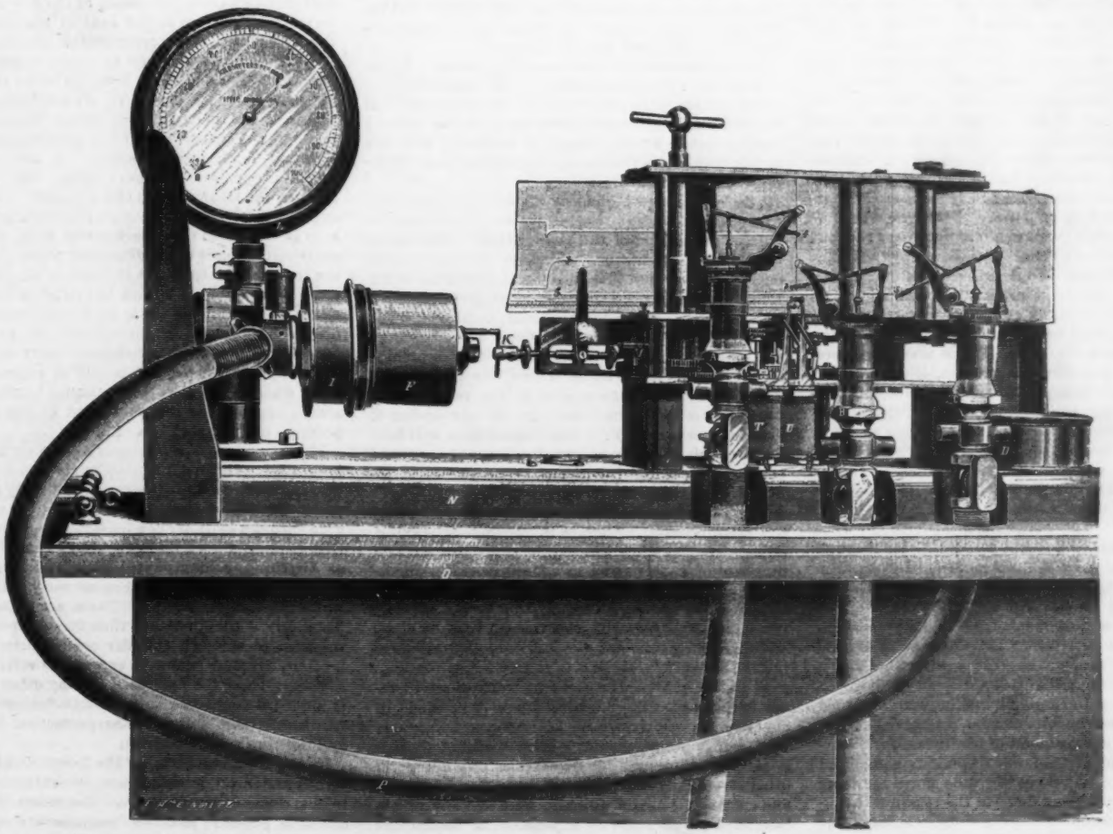
$$\text{P. c. efficiency} = \frac{\dfrac{\text{vel. head due to speed}}{\text{distance run in sta. of 100 ft.}} - \text{grade of rolling friction (taken as 0.5)}}{\text{P. c. of total wt. of train to which brakes were applied.}}$$

At the completion of the runs recorded in the tables, the train No. 1*c* was taken up an incline 7.5 miles long, with an average inclination of 1.25 per cent. and curves of 2,000 ft. radius, with three stations on the incline, and the train was taken down this incline with an average speed of 31 miles. Of this descent it is stated that the variations in speed did not exceed 9 per cent., and the control of the descent was, in other respects, quite satisfactory.

In obtaining these records of the results of brake experiments, the very ingenious automatic recording apparatus illustrated, devised by Mr. ALBERT KAPTEYN, was used. In the trials at Carlsruhe it was placed in an experimental "van" in the rear of each train. Telephonic communication was established between this van and the engine, while, in addition, the driver's brake valve was fitted with an electric contact, so that its position was instantly transmitted to paper in the experimental van. The electric leads were fitted under the footboards at both sides of the carriages, and the necessary batteries placed in the rear van.

f the recording instrument in the experimental van a clear conception will be gained from the diagram. An endless coil of paper *a*, guided by vertical rollers *b*, *c*, *d*, *e*, *f*, *g*, travels with a regular speed obtained from a strong clock-work. The roller *h*, being grooved and driven in close contact with the roller *g*, pulls the paper uniformly at the desired speed. For the purpose of registering the various pressures, four indicators are attached; of these our engraving shows only three, the fourth having been added only recently for these particular experiments. Indicator *C* is in connection with the speed indicator *F*, and shows the pressure in this, recording miles per hour. Indicator *E* shows the pressure in the reservoir, *A* in the brake cylinder, and *B* in the brake pipe.

It will thus be understood that, while the commencement of the action of the brake is transmitted electrically and is of course momentary, the conditions of pressure in the pipes are only measured after the action has traversed the whole length of the train, some 1,500 ft., and passed 30 triple valves. The last-named indicators, *A* and *B*, mark their indications vertically, one above the other, producing the lines 3 and 4, while three more indications in the same vertical line are produced by the electro-magnets *T*, *U*, and *V*, but the lines produced by indicators *C* and *E* have to be shifted in a horizontal direction to their proper position to enable a direct reading to be obtained. Turning now to the electro magnetic contacts, it will be seen from the diagram that magnet *T* is in communication with a clock *D*.



Kapteyn's Automatic Time, Pressure, Speed and Distance Recorder for Brake Tests; Baden State Railways.

which makes one contact every half-second; the pointer on this magnet therefore produces a saw-tooth line showing half-seconds; magnet *U* is in circuit with the driver's brake valve, and produces a mark in the line at the moment the valve is opened, while magnet *V*, not visible in the view, is worked by an arrangement of gear wheels derived from the speed indicator, which makes contact once every 10 meters run. In addition to these elaborate arrangements for observation, an apparatus, designed by Mr. HANSHALTER, was erected in the experimental van, which showed the average speed during every 12 seconds. This last instrument had its own independent driving-shaft, but when the speed became uniform, its readings agreed excellently with the KAPTEYN speed indicator.

It will thus be understood that from the dia-

grams obtained on this apparatus it is possible to read the following information: Time which elapsed between opening of driver's brake valve and this action being transmitted to last carriage; the distance run; pressures of air in the reservoir, brake pipe, and cylinder, before, after, and during any moment of the stop; and the speed at any moment during the experiment.

That with such appliances there should be no difficulty in obtaining exact readings for all the headings of columns under which the results are tabulated it is needless to point out, but so carefully were all contingencies provided for and so perfect was the operation of Kapteyn's recording instrument, that during the 18 trials, extending over two days, not one observation was lost.

Compound Locomotives.

At the meeting of the New England Railway Club on April 10, Mr. ANGUS SINCLAIR, of Chicago, Secretary of the American Railway Master Mechanics' Association, read the following paper on Compound Locomotives:

The interest of American mechanical engineers in compound locomotives has lately been stimulated through the importation by the Pennsylvania Railroad Co. of a compound locomotive built according to the designs of Mr. F. W. WEBB, the famous locomotive superintendent of the London & Northwestern Railway, one of the pioneers in this line of engineering progress. The existing awakened interest in the subject is my excuse for offering the compound locomotive as a theme for discussion.

Compound locomotives have been working successfully on European railways for upwards of twelve years, yet practically nothing has been done on this continent to demonstrate the value of this system of steam using, an apathetic condition that may be attributed partly to two causes: 1. That antipathy which American locomotive designers have always displayed to any change of form likely to increase complication of parts. 2. The fact that no heavy pressure has ever been put upon our railroad mechanical officers to effect rigid economy in the use of fuel. Although the desirability of using fuel economically has been much discussed among us of late years, on many roads enginemen still act as if the coal placed on tenders were as cheap as the water passed into the tanks. While these ideas prevail sufficiently to influence opinion, little practical interest will be displayed in compound locomotives, or in any other improvement of railway motive power offered for the purpose of preventing waste of heat.

As most of you are aware, a compound engine passes the steam through two or more cylinders for the purpose of utilizing to the fullest extent its expansive force. The economical advantage to be derived from making steam perform work through its expansive force has been recognized ever since the steam engine was successfully applied to manufacturing purposes; and it was the desire to convert the expanding faculty of steam into mechanical energy that first led to the proposal to expand the steam in more than one cylinder. Over a century ago JONATHAN HORNBLOWER patented a compound engine in England, and he was succeeded at various times by others who attempted to improve upon the arrangement of his invention. During the first half of this century, many compound engines were built, and they became noted for their durability, which was due to the strains being more evenly distributed than in simple engines; but owing to the low pressures of steam in vogue, there was no marked economy in the use of fuel. In fact, the operation of the early compound engines had led many physicists and engineers to conclude that no economy could result from the expansion of steam in more than one cylinder. As early as 1825, JAMES P. ALLAIRE, of New York, built for marine service compound engines that used the steam more economically than any engines that ever had been worked up to that time; but American engineers were prejudiced in favor of the light, high-pressure, high-speed engines which had become the national type, and ALLAIRE'S ingenuity, skill, and enterprise did nothing to convince the engineering world that the compound engine had the inherent right to become the engine of the future.

Not until 1854 did the forerunner of the most advanced and economical steam engine yet invented appear, the designer being JOHN ELDER, a member of a well known ship-building firm of Glasgow, Scotland. ELDER was an accomplished mechanical engineer and an industrious investigator into the peculiarities of heat phenomena. He perceived that the compound engine had proved more efficient than the single-cylinder engine, only when the pressure of steam carried, and the extent to which expansion was carried, exceeded the practice customary at that time. Following the obvious teaching of this fact, he applied high-steam pressure and a high ratio of expansion to well-designed compound engines of the modern vertical inverted type, and at once reduced the coal consumption from 5 lbs. to 3¼ lbs. per H. P. per hour. As boiler pressures were still further increased and greater improvements effected on the mechanism, the coal consumption was reduced below 2 lbs. per H. P. per hour.

This was the greatest improvement that has been effected on the steam engine since the separate vessel as a steam condenser was applied, and the economy of fuel that resulted has made the high speed now common in marine service possible. The change to compounding was not, however, consummated without strenuous opposition, many engineers of high repute fighting, step by step, in favor of the simple engine.

When the compounding of marine engines became a generally recognized success, the principle soon made progress into stationary engine practice. Locomotive designers next took up the idea of expanding the steam in more than one cylinder, and within the last ten years about 600 compound locomotives have been built and are now at work.

If the opposition to compounding marine engines was stormy, the antagonism to the application of the principle to locomotives has been cyclonic. If the compound locomotive ever becomes the railway motive power of the future, it certainly will not attain popularity though apathy on the part of the opponents of change.

The fundamental purpose of all intelligent improvers of the steam engine is, to convert an increased proportion of the heat energy in the steam that passes from the boiler into the mechanical energy that drives machinery and performs other kinds of work. An axiomatic principle recognized by all engineers versed in thermodynamics is, "The higher the temperature of the steam when it enters the steam cylinder, and the lower that which it reaches before the exhaust occurs, the greater will be the efficiency of the engine, if the reduction of temperature has been caused by the conversion of heat into useful work." The engine that will best perform this function of transforming the energy of heat into work will in the end prove the most efficient machine.

Locomotive improvers have clung very ardently to a certain sound principle in steam engineering, and generation after generation since the time of Stephenson have moved in cycles, working on the problem of getting the steam quickly in the cylinder at near boiler pressure, cutting it off at the shortest possible point consistent with the work to be done, and expanding it as low as practicable before opening the exhaust. Mr. D. KINNEAR CLARK, the eminent engineer, who wrestled long with different investigations into the most economical methods of operating locomotives, came to the conclusion, nearly half a century ago, that expansive working was expensive working; yet his discoveries did not deter others from laboring to perfect means for admitting and cutting off steam quickly, with a view of obtaining a high ratio of expansion in locomotive cylinders; but labors in this direction have uniformly resulted in disappointment. CLARK, who first demonstrated that a high ratio of expansion in a locomotive cylinder was not conducive to economy, discovered and explained the cause, and at the same time furnished a rational solution of the difficult question why a compound engine, providing for a higher ratio of expansion than a simple engine, might yet be more economical.

This discovery was to the effect that the cylinder of a steam engine acted alternately as a condenser and as a boiler, condensing a portion of the steam during admission and revaporizing the resulting water of condensation during the period of expansion and exhaust. This was due to the interaction of the metal of which cylinders are made, and would not happen if a non-conducting material was employed; but as all metals suitable for the construction of cylinders are good conductors of heat, the alternate condensing and revaporizing of the steam is inevitable, and its evil effects are magnified in proportion to the difference in the variations of temperature.

Owing to the defects of the valve motion used on locomotives and other causes, steam is seldom cut off earlier than quarter stroke, which permits an approximation to four volumes of expansion. This is not pronounced enough to develop the evils of cylinder condensation in an aggravated form. But suppose, by the use of an improved motion, it is made practicable to admit steam for only 4 ins. of a 24-in. stroke. The expansion then will be 6 volumes, and it will be found beyond the line of economical expansion in simple locomotives. Suppose the steam is admitted at 160 lbs. absolute pressure, or a little over 145 lbs. gauge pressure, and expanded to 6 times the original volume. The exhaust pressure will be about 26 lbs. The temperature of the steam on admission would be 363° Fahr. and at release it would be 242°, making a variation in the temperature of over 120°. The metal of the cylinder tends to adjust itself to the temperature of the steam, giving or taking heat during the recurring events of the strokes. The cool exhaust steam has imparted a temperature to the cylinder, and when the hot steam from the boiler passes through the ports at the beginning of next stroke, it goes into a comparatively cool cylinder, the metal of which absorbs heat till it is raised to the temperature of the steam. Saturated steam is constantly at the dew point, and on the least portion of the heat of vaporization being abstracted, the corresponding quantity of the steam falls into water just as it does inside the condenser. When the steam becomes water in the cylinder, it loses its power to do mechanical work; therefore the percentage of steam that condenses through the interaction of the cylinder metal represents so much loss of power. A portion of the steam condensed becomes spray, and helps to dampen the steam filling the cylinder. When the steam is cut off and expansion proceeds, part of the heat is converted into mechanical work, and a proportional amount of condensation takes plate. By the time the release point is reached, the pressure of steam has become low, and the relief of tension inclines the water to flush back into steam, and it draws on the metal of the cylinder for heat which acts as fuel to turn the condensed water into steam. This happens during the period of release and return, when that end of the cylinder is open to the atmosphere, so the revaporization of the water represents unmitigated loss of heat.

This may appear a fine-spun theory to those who have not studied steam matters closely; but it is a theory based on the discoveries of highly practical men. The serious losses that occur in the steam engine through cylinder condensation and revaporization are well-known, and have been as clearly proven as anything belonging to steam engineering; yet few railway men act as if they properly realized the importance of the matter. There are probably few locomotives that lose less than 20 per cent. of the steam used through cylinder condensation. Locomotive cylinders are more exposed to refrigerating influence than the cylinders of any other form of engine: yet very little attention is bestowed upon furnishing them with the best protection that care and ingenuity might devise.

In the compound engine the losses due to excessive cylinder condensation are prevented by avoiding extremes of temperature. The steam of 160 lbs. absolute pressure and 363° temperature would be cut off in the high-pressure cylinder at about ⅙ stroke to obtain 6 volumes of expansion, and passed into a receiver at a pressure of 53 lbs. and temperature of 285°. The difference in temperature between the initial and the terminal pressures in the low-pressure cylinder would be even less pronounced. Any revaporization of water that follows condensation in the high-pressure cylinder does not cause much loss in a compound engine, for the regenerated steam passes into the receiver and is utilized to perform work in the low-pressure cylinder instead of escaping uselessly into the atmosphere as it does from the cylinder of a simple engine. These are the causes that make expansion of steam in the successive cylinders of a compound engine more economical than the same ratio of expansion carried out in a single cylinder.

The business of operating European railways is

done on a very close margin of profit, and the officers in charge of machinery are constantly under urgent pressure to effect saving wherever it is possible. Economy of fuel has always received strict attention, and the saving effected by compound engines in marine service made locomotive designers anxious to obtain a share of the saving for railway motive power. An attempt was made in England to introduce the compound principle in locomotive practice even before it was made a decided success with marine engines. As early as 1860 Mr. JOHN NICHOLSON, an engine driver on the Great Eastern Railway, designed a compound locomotive, and several were built and used for a few years. He had a high-pressure cylinder on one side and a low-pressure cylinder on the other, live steam being used in both cylinders for starting. The cylinder ratio was 1.2. The proportions were as good as anything produced by later designers, and I see no reason why NICHOLSON'S engines were not made a permanent success, except that no influential railroad officer was interested in floating the system over the shoals encountered by all improvements in railway motive power when they are first introduced.

To a French engineer belongs the credit of originating the movement that has made the application of compounding to locomotives a success. Mr. ANATOLE MALLET became convinced that the locomotive could be materially improved by compounding, and he advocated the change so convincingly that in 1876 the Bayonne & Biarritz Railway Company had two compound locomotives built according to his designs. The engines were in a great measure experimental, but they proved a decided success. The general design was as good as anything subsequently brought out, but experience has modified some of the proportions adopted. The engines had outside cylinders, that for high-pressure steam being 9¼ ins. diameter, and the low-pressure cylinder 15¾ ins. diameter, the ratio of size being 1 to 2.78. The stroke of both pistons was the same, viz., 17¾ ins., and the cranks were set at right angles, as in common locomotives. Provision was made for passing steam direct from the boiler to both cylinders in starting or on heavy grades, but the ordinary method of working was to admit steam from the boiler into the high-pressure cylinder only. After following the piston in this cylinder as far as the train pulled renders necessary, the steam is cut off and expanded to the finish of the stroke, when it is exhausted into a receiver of about the same capacity as the high-pressure cylinder, from whence it passes into the low-pressure cylinder, admission being regulated by an ordinary slide valve. The steam receiver and the method of admitting steam to the cylinders were the principal improvements which Mr. MALLET made over the compound locomotive designed by Mr. NICHOLSON.

The Mallet system with a few modifications was adopted by Mr. VON BORRIES, Mechanical Superintendent of the Hanover Railway; by Mr. T. W WORSDELL, Locomotive Superintendent of the Great Eastern Railway of England, and many other mechanical heads of railroad companies, so that under different names there are more compounds of the Mallet design at work than of all other types of compound locomotives combined. The leading features of the engine are a single low-pressure cylinder and a single high-pressure cylinder connected to cranks set at right angles, the ratio of cylinders being about 1 to 2. Slide valves are used which cut off steam in either cylinder at the points found most desirable for economical working. A receiver of about the capacity of the high-pressure cylinder intervenes between the high and low-pressure cylinders. The engine is very little more complex than a simple locomotive.

Two years after the first compound locomotive built according to the Mallet plans were put into service, Mr. F. W. WEBB, Locomotive Superintendent of the London & Northwestern Railway, converted an old locomotive into a compound on the same general design. This engine was kept at work regularly for three years, and a close record of her performance convinced Mr. WEBB that the compound principle was worthy of a more extended trial. There is a great antipathy among English engineers to the use of side-rods in high-speed locomotives; and Mr. WEBB conceived the idea of utilizing the compound principle in such a way that the necessity for coupling rods would be obviated. This conception was reduced to practice by the designing of a three-cylinder compound locomotive consisting of two high-pressure cylinders placed outside the frames and connecting with the back pair of driving wheels, and a single low-pressure cylinder placed under the smoke-box, and transmitting power to the front pair of driving-wheels through the medium of a cranked axle. After considerable changes were effected, suggested by experience with successive engines of this general design, the inventor settled upon the style of engine lately purchased by the Pennsylvania Railroad Co., and spoken of by the designer as being of the "Dreadnought" class. This locomotive has three cylinders of 24-in. stroke. The high-pressure cylinders are each 14 ins. diameter, and the low-pressure cylinder is 30 ins. diameter. The ratio of high-pressure cylinder to low-pressure cylinder is 1 to 2.3. This is a larger proportion of low-pressure cylinders than most other designers of compound locomotives have adopted, but it has been settled on by Mr. WEBB after considerable experience with different ratios. According to marine engine practice, the measure of a compound engine's capacity is the size of the low-pressure cylinder. This applies to compound locomotives only after the engines have got into running speed. When working in this way, the Pennsylvania compound locomotive has a cylinder capacity equivalent to that of a simple engine with cylinders 21.21 by 24 ins. For starting a train from rest, however, the engine has a power equal only to the capacity of the two 14 by 24 high-pressure cylinders.

Steam passes from the boiler to the steam chests of the high-pressure cylinders, which are placed beneath the cylinders, and admission is regulated by Allen valves working below the valve seat. An advantage of this arrangement is, that the valves fall away from the seat when the engine is running without steam, and the pumping action of the pistons is prevented. After doing its work in the high-pressure cylinder, the steam is exhausted into a receiver of about the same cubic content as the high-pressure cylinders, formed of pipes in the smoke-box where the steam gets slightly re-heated. From this receiver the steam passes into the low-pressure steam chest located above the cylinder, and its admission into the cylinder is regulated by a common D-slide valve. After doing its work in the low-pressure cylinder, the steam escapes into the exhaust pipe, and thence by way of the smoke-stack into the atmosphere. The valves are operated by Joy's valve motion.

The Webb system of compounding locomotives is better known to American railroad men than any of the other systems, through having been illustrated, described, and discussed very freely in railroad and engineering journals; but the Mallet system has been applied to the greater number of locomotives. The improvements applied to the Mallet compound by Messrs. WORSDELL, VON BORRIES, and others, have made it about as easy to operate as a simple locomotive. As has already been mentioned, this form of compound locomotive has two cylinders set in the positions usually occupied by the cylinders of simple engines, the high-pressure cylinder being on one side, and that for low pressure on the other. Most of these engines are now provided with an automatic starting valve, which admits wire-drawn steam to the low-pressure cylinder direct from the boiler, and closes when one turn of the driving wheels has been made. Engines of this kind are working in England, Germany, France, Russia, Spain, India, Brazil, the Argentine Republic, and other countries.

Various other forms of compound locomotives have been built, and each kind has its own friends and advocates. On the Northern Railway of France, compound locomotives of the Sauvage design have the cylinders arranged in the reverse way to Mr. WEBB'S, the high-pressure steam passing into a single cylinder under the smoke box, and expanding in two low-pressure cylinders set one at each side outside the frames. On the same line, they have Woolf four-cylinder compounds, the cylinders being arranged tandem, the low-pressure in front. Several engines have been built with two high-pressure cylinders outside, and two low-pressure cylinders inside, the latter connecting with crank axles. The complication and expense of this method of construction are likely to make the application of the design limited.

As the principal object in applying the compound principle to locomotives has been to effect saving of fuel, special attention has been devoted to the compiling of correct records of the relative cost of service performed by simple and compound locomotives. One cannot examine the returns sent in from the mechanical superintendents of railways in nearly all quarters of the globe, without being convinced that the compound work more economically than simple locomotives; but it is exceedingly difficult to estimate a fair average of the measure of saving. The reports make it vary from 10 to 25 per cent. of saving in the quantity of fuel used. Probably 15 per cent. of saving might be a fair average.

Compounding in itself does not bring about all this saving, as a considerable share of the economy must be attributed to the higher pressure of steam used; but a conspicuous merit of the system of compounding is that it provides the means of taking more of the potential work out of high-pressure steam that can be utilized with a simple engine where the facilities for expansive working are so limited.

There are other incidental advantages in the manner steam is used in a compound locomotive which, no doubt, contribute to swell the saving of fuel. The prevention of condensation and re-evaporation of steam, through the avoidance of extremes of cylinder temperature, has been already alluded to. When the steam is worked through two cylinders, there is considerably greater pressure on the pistons when the cranks are near the quarter than with a single cylinder using steam expansively; hence, there must be superior rotative effort. The average unbalanced pressure on valves and pistons is also less on a compound than on a simple engine, so that leakage of steam will be diminished. As a compound engine uses 15 or 20 per cent. less steam than a simple engine to do the same work, the boiler has not to be urged so hard to evaporate water, consequently a larger exhaust opening can be used; and as that means a slower velocity of fuel gases, there will be fewer sparks drawn through the tubes.

On the other hand, a compound locomotive is more expensive to build than a simple one. If a boiler has to be built capable of carrying a working pressure of nearly 200 lbs., the original cost and the expense of repairs will be increased. The additional mechanism of a compound locomotive must increase the expense of maintenance, and the risk of failure or delay through breakage or the parts getting out of order is greater.

The ordinary American locomotive could be converted into a compound with very little expense or structural change. The Mallet system could be applied by changing one cylinder, and the extension smoke-box would be a highly convenient receptacle for the steam receiver. Although the design of the American locomotive would enable our master mechanics to compound their engines at very little expense, the present system of operating the train service would make a compound locomotive of any existing type unsuitable for doing the work. Economy of fuel in operating locomotives is held to be of much less importance than that of having an engine which will pull the last car possible out of a yard or over a grade. To comply with this demand, our locomotives are built to exert every pound of traction that the adhesion on the driving-wheels makes possible. Our stations and stopping places are so numerous that, unless a locomotive is capable of exerting her full power the moment the throttle is opened, she will lose time on passenger trains, delay traffic with freight trains, and soon become a reproach and a nuisance.

There has been no compound locomotive built that is capable of meeting the existing conditions of American train service. The most successful compounds are very powerful engines when working the steam expansively, but they are incapable of exerting, in starting a train, or during a slow pull, the full tractive force which the adhesion admits of. The Pennsylvania Webb compound, with its 14 by 24 high-pressure cylinders and 30 by 24 low-pressure cylinder, exerts a starting force only equal to the power developed in the small cylinders. When the train is once moving, and the low pressure cylinder is exerting its power, the engine can do rather more work than a simple engine with cyl-

inders 21¼ by 24 cutting off at three-quarter stroke, which provides a high maximum power at the time it is not urgently needed. In the Mallet system, it is usual to admit live steam to the low-pressure cylinder in starting, and shut it off automatically when the wheels have turned a revolution. This, in practice, would be equivalent to pulling back the reverse lever of a simple engine to the 12-in. notch the moment a single revolution of the wheels had been made. It is unnecessary to dwell on the inconvenience that such an arrangement would cause with our method of handling trains.

If compound locomotives are ever to be used successfully in this country, they will have to be designed specially to meet the requirements of our train service. Mr. A. N. TOWNE, general manager of the Southern Pacific, lately made a statement to the effect that coal for the company's locomotives costs them $6 a ton in San Francisco, and they have to haul it in some cases thousands of miles to the divisions where the fuel is used. The enormous saving that would result to the Southern Pacific Co. and other roads from a reduction of 15 per cent. of the coal consumed will some day bring about a fair trial of compound locomotives in this country. When that time comes, an important element of success will be due to the engineer who designs a compound locomotive with simple, efficient, and durable appliances for transforming the engine into direct acting or compound acting at the will of the man in charge. American inventive genius ought to be equal to supplying this demand.

DISCUSSION.

Mr. LAUDER.—I think the gentleman who has just favored us with a paper on the subject of compound locomotives, has struck the keynote when he states that it would be impossible to adapt the compound principle to locomotives under the existing conditions of train service in this country. There is no doubt that if the compound principle could be adapted to locomotives, giving the engine such trains as it could handle, there would be a large saving in fuel; but in this country the question of fuel has been of secondary importance, the first consideration being to get a locomotive to do the work required. I believe the railroads of this country could be more economically worked, and as satisfactorily, if every engine could be rated, and its load stated in cars or tons, according to the grades of the road, and at no time a greater load put on to an engine than its rating indicated for it. In that way I think the compound engine could be successfully used in this country, and with economy. In European countries the engine hauls a much lighter load than with us. Here there is a continual demand for more powerful engines, something better and stronger than anything we have got. We cannot go much farther in that direction; I believe the limit of weight of engines has already been exceeded, especially with our fast trains, for the best service, and that in the future we shall come to have lighter engines and correspondingly lighter loads. The result of an accident to a train weighing 500 tons going at a speed of 50 or 60 miles an hour is something fearful to imagine, and vastly worse than with a train weighing only 100 tons. Until we lighten our trains and our engines, I do not think the compound principle can be successfully applied.

Mr. CONEY.—I remember when I learned my trade, over 40 years ago, that the evaporation of 7.5 lbs. of water to a pound of coal was thought to be a fair rule; but it is doubtful if any boiler at that time, stationary, marine, or locomotive, evaporated more than 5 lbs. of water to a pound of coal. Now, such improvements have been made in the use of steam, I believe we shall soon see the compound locomotive built which will be used on our railroads. That is highly probable, when we consider that within our remembrance engines were used which required 5 lbs. of coal per H. P. per hour, and now we see enormous steamers crossing the ocean their engines developing a horse power per hour from 1.75 lbs. of coal or even less. The consumption of fuel is a matter of great importance to railroads, especially where the coal fields are at a distance. In Massachusetts, a saving of 15 per cent. in the cost of fuel would mean a dividend of one per cent. to the stockholders. Some years ago the Government built six vessels with compound engines, which were guaranteed by the contract to develop a certain horse power; I think they were to produce a horse power with 3.5 lbs. of coal per hour; and they did it. Within ten years I compounded two engines, and guaranteed to get a horse power with 3.75 lbs. of coal per hour, and did it. When we see the vast improvements made in stationary and marine engines, it is fair to presume the locomotive will be equally improved, both as regards economy in the use of fuel, and in other ways, and that the compound locomotive will supersede our present engine for railroad uses.

Mr. BARNES.—I have been riding on the new English compound engine, which is being broken in for service running with two other engines (a triple-header) doing ordinary work, with a view of finding out her value within certain limits, it being the intention to place her on the New York division of the road. Upon starting, the boiler pressure is 175 lbs.; the steam is admitted into the high-pressure cylinders full stroke, then into the low-pressure cylinders; the exhaust from them after starting on low pressure is about 40 lbs. on a heavy grade. I noticed in going up a very steep hill, which required the three engines to pull up an ordinary train, that the compound engine, while doing all it was capable of, made hardly any smoke, while the other two emitted large volumes of black smoke. This absence of smoke is due to her large grate surface in proportion to the weight on the drivers, to the very thin copper tubes which she uses, and to the smaller consumption of fuel; then the fire-door opens inward, and the air entering the fire-box is deflected and burns the smoke. The Pennsylvania road has been considering the building of a compound engine for some time, and is experimenting with this one, to test its power. They are now building at Altoona, to compete with this, one as good as can be built, to run with a pressure of 175 lbs.

With regard to cylinder condensation, the best English authorities (the English have had more experience with compound engines than any other nation) dispute that there is any great gain as the result of decrease of cylinder condensation with compound engines, while they admit there is a small gain. It was found in using quadruple cylinders they had to carry a pressure of over 200 lbs., whereas with three cylinders 170 to 180 lbs. was ample; and it is claimed that the great advantage of compound over plain engines is due to the fact that you can use a higher pressure of steam and expand it properly. Mr. ELS called attention to the fact that, while the compound engine is making steam enough to run about 20 miles per hour, with 6,700 lbs. weight on the drivers, the exhaust takes place only half as often as on our engines, there being twice the interval between blasts, the fire burning beautifully. The exhaust nozzle is 4.75 ins. in diameter.

THE PRESIDENT.—I will read some extracts from letters from Mr. F. W. WEBB, the Superintendent of the London & Northwestern Railway, and the designer of the compound locomotive now being tried on the Pennsylvania R. R. Under date of Dec. 24, 1886, he writes:

"The compound locomotive is capable of taking 20 carriages at express speed. The sister engine to the 'Marchioness of Stafford' on her first trip to London took a load equal to 14.5 of our 6-wheeled carriages to Rugby, 75.5 miles, thence to London with 13 carriages, 82.5 miles; total distance, 158 miles. coal per mile, 269 lbs. Time occupied 3 h. 19 min." (Average per hour, 47.64 miles).

Feb. 26, 1887, he writes: "Weight of 'Marchioness of Stafford,' 42 tons, 10 cwt.; weight on high and low pressure driving wheels, 15 tons each."

Jan. 31, 1889, he writes: "We have at the present time running on the London & Northwestern Railway 70 compounds, doing fast passenger work; 30 of them with 6-ft. 6-in.-wheels, 13-in. outside cylinders, and one 26-in. inside; and 40 of them with 14-in. outside, and one 30-in. inside cylinder. Also 2 compounds on suburban work, and 2 on some of our heavy gradient branches doing passenger work. Besides these, there are 16 compounds built on my system on other railways, which are doing well and saving considerably in fuel. In one case we have had a compound converted from a non-compound engine, and during the last four years this engine has been doing identically the same work as one of the same class of non-compound from which it has been converted, thus enabling one to form a fair comparison of the two systems. The compound has worked during this period on 23.2 lbs. per mile, against an average of 31 lbs. per mile, for the non-compound.

"On the L. & N. W. line up to Nov. 30, we have run 10,386,389 miles with this type of engine. The 30 smaller ones, working our Irish mails and other fast traffic between London and Holyhead, have run 5,960,830 miles, with an average consumption of 30.2 lbs. of coal per mile."

The distance from London to Holyhead is 263.75 miles, and the fast trains make the run in six hours, including several stops; average per hour 43.96 miles; passengers from America landing at Queenstown, thence to Dublin, thence by steamer to Holyhead, thence by rail to London, saving several hours, and rapid transit is called for.

"The 40 large locomotives doing our main line work between London and Carlisle have run 4,133,613 miles, with an average consumption of 36.6 lbs. coal per mile.

"From the mileage we have run with the number of engines, you will see from the fact that they have averaged over 42,255 miles per annum that they have not been nursed; and in some cases the engines are double gauged, running from Crewe to London and back every day except Sunday, a distance of 316 miles per day."

Under date of Feb. 1, 1889, the agent for the Worsdell & Von Borries system, writing from London, says:

"We have about 360 compounds running and under construction. Comparative trials have shown an economy of fuel consumption in favor of compounds of from 15 to 20 per cent."

Mr. LAUDER.—If we have got to use compound engines in order to secure economy of fuel we have got to run lighter trains, and consequently more trains to do the same amount of work we are doing now, and we might in saving $10 a day in fuel spend $100 in other directions. There are many expenses connected with the running of trains besides that of fuel,—salaries of officers and men, tools, baggage cars, signal lights; and additional engines would also be required: all these things are to be considered. I believe we now transport passengers and freight cheaper than anywhere else on earth a certain number of miles, notwithstanding we have to pay at least twice as much for our labor.

Mr. WEBB.—Out West the engines are rated; every engine belonging to the Chicago division of the western roads has its rating, taking into consideration the maximum grade where it is to run, and that rating is based on the utmost the engine will do without starting the flues leaking so the fire will go out before it gets back; and they carry that to an extraordinary extent. The trains starting from Aurora eastward go up a grade of about 80 ft., and when hauling corn are helped out of the yard by one or two pushers. Until those conditions are materially changed, I don't see but the compound locomotive will have to wait. In regard to economy of fuel, that question is of more importance in some sections than others, for instance in lower California and perhaps here in New England; while in the West, coal is much cheaper, the highest price paid by the C. B. & Q. being $1.25 per ton and there are many lines where coal is delivered by the side of the track. I think the first solution of the problem of greater economy is in the increase in the square feet of grate surface rather than in the cylinder.

Mr. BARNES.—I do not know of any reason why we should assume that a compound engine should not have sufficient power to start the train it is to haul. An engine built on the VON BORRIES plan should have just as much power in starting a train as any engine in America, and there are compound consolidation engines and Mogul engines in Europe, in the Saxony States particularly, which start heavy trains satisfactorily and haul them up heavy grades.

A Great Rock Excavation.

A great piece of rock excavation is now in progress at the Tilly Foster mine, near Brewster's Station, N. Y., on the New York & Harlem Railroad, which is a remarkable example of quick and rapid work, and especially of the economy and convenience of wire rope haulage for disposing of the spoil, whether it is wasted on the spot, or loaded on to cars for dumping elsewhere.

The Tilly Foster is an old and valuable mine, and has been extensively worked for many years. The ore is of the best quality, and worth in the market about $5 per ton, but the expense of getting it has been very great, some $3.50 per ton, owing largely to slippage of the nearly vertical and very irregular strata. To reduce this heavy cost, it was determined to convert the mine into an open cut by the removal of no less than 329,000 cu. yds. of rock, which it was calculated would uncover at least 600,000 tons of ore, and which now seems likely to uncover as much as 1,000,000 tons, enabling it all to be quarried rather than mined, with a very large saving, even after loading it with the cost of the rock excavation.

The contract for the latter was let, after a sharp competition, to Messrs. STEVENS & ARNOLD; and Mr. CLINTON STEVENS, the head of the firm and resident manager, has certainly shown great skill in conducting the work. The contract price was $1.15 per cu. yd. Work was started about 20 months ago, and the excavation is now, roughly speaking, 450 ft. long, 300 ft. wide on top at the widest point, and 168 ft. deep. Up to date, about 200,000 cu. yds. of rock has been taken out, and some 35,000 tons, or say 15,000 cu. yds., of ore mixed in with the rock. The ore is taken out at a separate and higher contract price, by an arrangement subsequent to the original contract for the rock, and the separation of it from the rock naturally involves considerable extra expense for getting the rock itself, for which some allowance is to be made. Mr. F. H. MCDOWELL is Engineer-in-Charge.

The rock consists of hard and much stratified and broken gneiss, mica schist, coarse dolomite, and serpentine. Its general character may be judged somewhat from our engraving. The many seams and inequalities of hardness make it anything but first-class material for either drilling or blasting, although there is much rock that is worse. During the first six months or so, work was not prosecuted nearly so vigorously as it has been since. Rand drills are used (of which only 10 have been required) and rackarock as an explosive. About 200 men are now employed for all uses, but in connection with the rock work only, apart from the ore getting, about 150 men has been the average force, the pay of the common rock men ranging from $1.25 to $1.50.

The cost of explosives on the whole work, so far, has averaged about 10 cts. per cu. yd., only. The cost of lifting the rock from the mine and wasting it—perhaps the most interesting feature of the work—has averaged only 5 cts. per cu. yd. The rock is all wasted within a few hundred feet of the

edge of the pit, convenient ground being available.

The hoisting plant consists (1) of a large derrick, 110 ft. boom, and (2) of the 4 cable hoisting plants shown in our engraving. The latter are very much preferred to the derrick, and by them practically all the work was done. The average time taken per round trip, from the time a loaded box is lifted until an empty one is returned, is 4 minutes, or 15 per hour, and in one day of 9 hours 153 boxes were lifted by tally, or 17 per hour. The boxes are 7 ft. 2 ins. square, and their load averages 1.1 cu. yds. The cost per day for running each cable, including coal, engine man, and signal and dump men is in the neighborhood of $8, making the cost for hoisting and wasting about 5 cts. per cu. yd. The excavation is to be carried down eventually to a depth of some 600 ft., but it will be seen that with this plant there is no great room for serious difference in cost on account of depth.

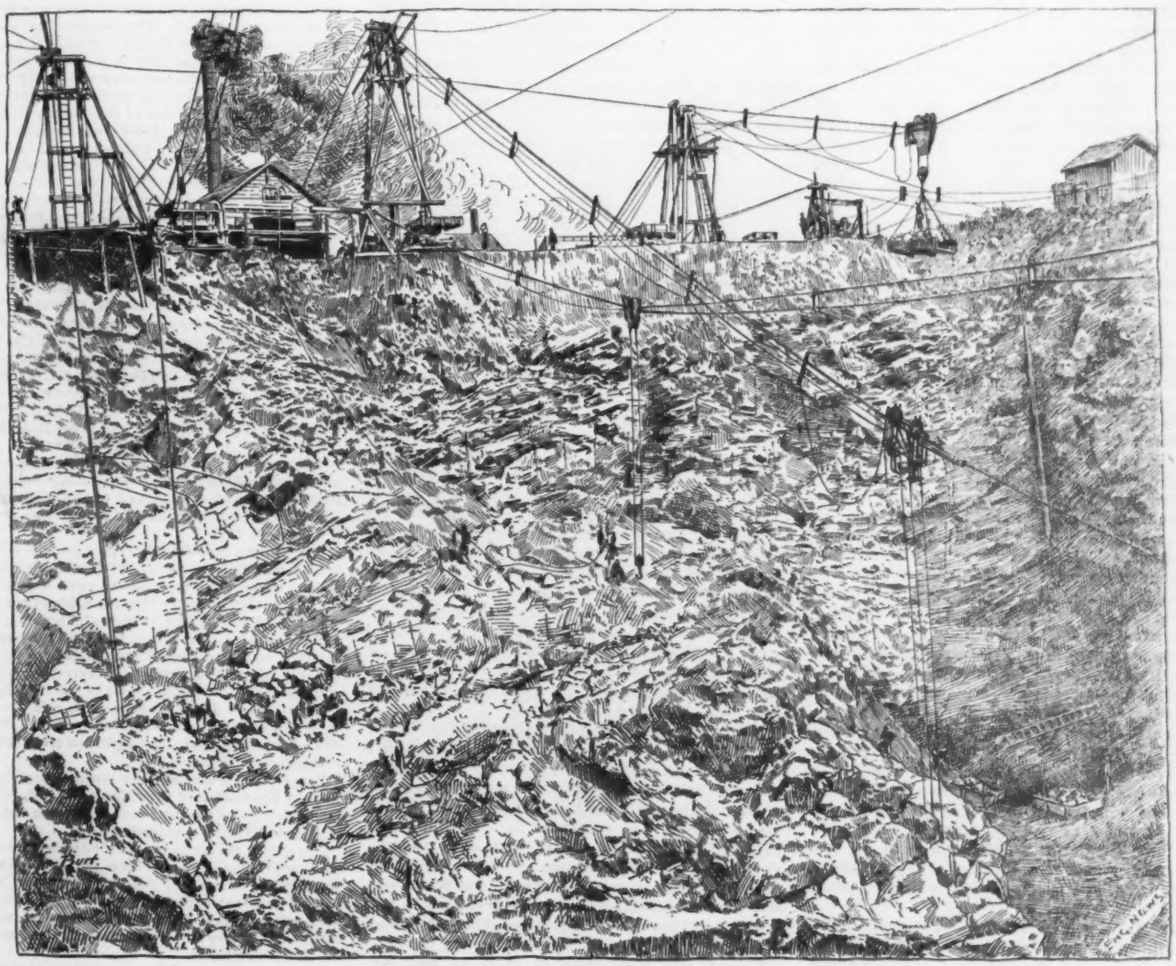
The average cube extracted per month when fully at work may be taken as about 12,000 cu. yds., or about 4,000 cu. yds. per cable; two of the cables having been in use for only half the time. Two of the cables are strung horizontally and can move the load to either side of the pit; the other two are sharply inclined downward, being anchored to the rock by eye-bolts. A "bunting-block" is then fastened on the rope at the point desired for the time being, and the hoisting rope first lowers the trolley to this point (as shown in the engraving) and then continuing to lower without stop, drops the box vertically. In lifting, the process is the reverse of this.

For the horizontal cables one Lidgerwood and one Beckett & McDowell hoisting engine are used, with double drums which work separately or together. The cost of engines only is about $2,150 and of the cable complete about $4,000. The main cables are all 2-in. and the hoisting rope ¾-in. The derrick cost complete, with masonry pedestal, $1,500. It is possible with these engines to move the load both horizontally and vertically at the same time, but this in practice is not done.

The boxes have trunnions under them which rest on shallow rests on light lorry cars with about 10-in. wheels. The rest is so high and so near the center as to make it easy to tip the boxes, and very heavy blocks of stone are allowed to slide off them without any annoying tendency of the boxes to jump off the supports. It is difficult to conceive of a simpler form of dump car, its whole weight, of oak, being about 1,300 lbs., yet it is very effective as well as cheap. A horse is used to move about the cars, and there is enough fine stuff in the rock to keep a good surface for shifting track, although there is now no earth coming out.

In ENGINEERING NEWS of Dec. 1, 1888, we described and illustrated an almost precisely similar hoisting gear as used at the Sodom dam, to which reference may be made for further details, especially as to the engines, and the admirable system of supporting the hoisting rope from the main cable by wooden blocks. These blocks are pierced with three holes. By the upper one the blocks ride loosely on the main cable; by a lower one the hoisting rope is supported; by the lowest one of all a light chain is attached connecting the blocks together so as to string them along the main cable at equidistant intervals as the trolley is run out. As the trolley comes home, the blocks bunch closely together and the connecting chain hangs vertically down from them.

This great rock cut is not only interesting in itself, as one of the deepest on the continent, or indeed in the world, but has a very direct bearing on the probabilities of success with the great cut on the Nicaragua ship canal project, as we have noted elsewhere.



A Great Rock Excavation: Tilly Foster Mine, Brewster's Station, N. Y.

Moncure Robinson, C. E.

WITH PORTRAIT.

MONCURE ROBINSON was born in Richmond, Va., Feb. 2, 1802. He was the son of JOHN ROBINSON, who married the daughter of WM. MONCURE, of the firm of Moncure, Robinson & Pleasants, of Richmond, a firm extensively engaged in the South American trade. The subject of this sketch commenced his education at an early age at the Gerardine Academy in Richmond, and at 13 years of age he entered William and Mary College, where his French tutor was M. FREMONT, the father of General FREMONT, and from this teacher Mr. ROBINSON acquired that familiarity with the French language which was so useful to him in after years.

Though his father was desirous that he should study law, the then novel profession of engineering proved more attractive to Mr. ROBINSON, and in 1818 he joined, as a volunteer, the topographic survey then being made across the State of Virginia to the Ohio. His mathematical acquirements soon made his services valuable, and in 1819 he paid a second visit to this region on horseback, and explored and located certain tracts of wild land owned by his father, but concerning which little, if anything, was known.

In 1821 we find him associated with Col. JOHN G. GAMBLE in the early construction of what is now a part of the James River Canal, and in this connection he was sent to examine the work then in progress on the Erie Canal. Introductions to Gov. DEWITT CLINTON and to CANVASS WHITE facilitated the young engineer's work of inspection, and in the same year he was engaged by Gov. PLEASANTS, of Virginia, as Chief Engineer of the James River Canal, which he extended from 3 to 30 miles in length. But Mr. ROBINSON already

seemed to appreciate the superiority of a properly graded railroad over canals for the purpose intended, and when afterwards called upon to still further extend this same canal, he expressed his disapproval, and strongly advocated the new system of railroads, and finally declined, in the interest of his State, to be a party to further canal construction.

Early in 1825 Mr. ROBINSON went to France and entered the advanced classes of the Ecole des Ponts et Chausses to gain further knowledge in his chosen profession. He spent about three years in Europe, visited the engineering works of France, Holland, England, and Wales, and made many acquaintances among the leading engineers of the day, including Mr. GEO. STEPHENSON, who was then constructing the Liverpool tunnel on the famous Liverpool and Manchester railway.

In the latter part of 1827 the subject of our sketch returned to the United States, and in the spring of 1828 he made the surveys of the Pottsville & Danville Railroad in the interest of STEPHEN GIRARD, who was then, with the State of Pennsylvania, interested in the development of the anthracite coal-fields, and personally contributed $500,000 towards the construction of this road. It was on this line that Mr. ROBINSON introduced cycloidal planes, using water for the production of power and regulating the working by stationary engines placed at the head of the planes. The death of Mr. GIRARD prevented the completion of this railroad on the scale originally proposed, but about 20,000 tons of coal per annum were transported over these planes, for about four years, and transferred to canal boats at Port Carbon.

In December, 1828, the Canal Commissioners of the State of Pennsylvania selected Mr. ROBINSON to make a survey of the Alleghany Portage Railroad, and in 1829 he made a report recommending a route ascending from Hollidaysburg by five planes and intermediate levels, piercing the summit by a tunnel one mile long—and 140 ft. lower than the present summit—and descending again with five planes and levels to the Johnstown basin. In 1830 Col. S. H. LONG made his report recommending eleven planes, and the two surveys were at once submitted to a board of engineers, which was unable to come to any decision between them. In 1831 Mr. ROBINSON made a second report, which, by its plain and concise statement of controlling conditions and the service expected from this mountain crossing, proved that the route recommended by him was advantageous to the State and the proper solution of the problem presented. His views were endorsed by JOHN B. JERVIS and HORATIO ALLEN, and later by the celebrated French engineer, MICHAEL CHEVALIER, who said that the avoidance of the tunnel, proposed in the work as carried out, greatly impaired the efficiency of the entire project. During this same year Mr. ROBINSON was also consulted by the State Commissioners concerning the location of the State railroad westward from Philadelphia, and by his advice Lancaster and Columbia were made points in the line. It might also be mentioned here that in 1828 Mr. STEVENS offered Mr. ROBINSON the office of Chief Engineer of the proposed Camden & Amboy Railroad, but a difference of opinions as to the appointment of assistants caused the offer to be declined.

In 1830 Mr. ROBINSON built, in Virginia, 13 miles of a railroad to reach the coal-field of HEATH & MILLS. On this road, the loaded cars, in descending a plane, hauled up the empty cars. The Pottsville & Danville Railroad, before mentioned, and this Heath & Mills coal road were among the very earliest operated lines in the United States, following as they do very closely upon May, 1827, the date of opening of the Mauch Chunk railway, the first line which really employed the services of an engineer in its location and construction.

In 1831 Mr. ROBINSON was engaged upon the Petersburg & Roanoke and the Petersburg & Richmond Railroads, and he built upon the latter road a bridge across the James river, which was 2,844 ft. long, in spans of 140 to 153 ft. and with the rails 60 ft. above the water. The cost of this bridge was $40 per lineal ft. These roads were completed in 1832, and in the same year Mr. ROBINSON commenced the construction of the Richmond & Fredericksburg Railroad and the Winchester & Potomac Railroad. In 1833 the Little Schuylkill Railroad was built by him as a feeder, operated by horse-power, to the Schuylkill Canal at Port Clinton. This road was afterwards adapted to the use of locomotives and connected with the extension of the Philadelphia & Reading Railroad from Reading westward.

Mr. ROBINSON was engineer of the Philadelphia & Reading Railroad in 1834, and to his experience and careful thought that line is indebted for the alignment and grades which have made it the greatest and most economical transporter of coal in the world. In 1836, Mr. ELIHU CHAUNCEY, the first president of this road, sent Mr. ROBINSON to England to negotiate the first foreign loan made by this company, and his presentations of the advantages of a railway in the Schuylkill valley, as contrasted with a canal, were so convincing that he secured a loan of $2,000,000 at 5 per cent. for the road and a conditional loan of $1,000,000 for the proposed extension.

Upon his return from England, in 1837, he found that the Flat and Black Rock tunnels on the line of the Reading road were nearly completed. These tunnels aggregated 2,869 ft. in length, and the stone bridge, with its four arches of 72 ft. span each near the latter tunnel, was probably the first structure of any magnitude built for a double-track railroad in this country. This bridge contained 3,471 cu. yds. of masonry, and cost $43,263, and it has successfully resisted the Schuylkill freshets for over fifty years. The Reading Railroad, from Norristown to Reading, was opened to traffic on July 4, 1838, and the location of the extension to Pottsville was commenced under Mr. WIRT ROBINSON and Mr. W. M. C. FAIRFAX, as Resident Chief and Principal Assistant Engineers. This Pottsville extension was opened in January, 1842.

In 1838 the firm of Eastwick & Harrison, of Philadelphia, built, on the designs of Mr. ROBINSON, the locomotive "Gowan & Marx," named after the English bankers with whom Mr. ROBINSON had so successfully negotiated the loan of the previous year. From the present standpoint, this locomotive was a small affair, having 12⅛ x 16 in. horizontal cylinders, with four-coupled drivers of 40-in. diameter and a fire-box 52-in. long, through which the rear axle passed. The weight was 24,640 lbs., of which 17,691 lbs. were on the drivers. This locomotive, in 5¼ hours, hauled a load of 441 tons, including engine and tender, over 54¼ miles of the line. A report upon the performance of this locomotive by the French Engineer, M. CHEVALIER, attracted the attention of NICHOLAS, Czar of Russia, who sent a commission to the United States to visit the locomotive works of the country, and finally invited Mr. ROBINSON to take charge of the then proposed Russian railway system. This offer was respectfully declined, but Mr. ROBINSON introduced the commissioners to Messrs. EASTWICK and HARRISON, and negotiations were opened which ultimately led to the removal of their works to Russia, and to subsequent contracts of great importance.

In 1839 Mr. ROBINSON was engaged by Gov. KING, of Georgia, to locate a line from Brunswick, Ga., across Florida to the Gulf, either for a canal or a railway. He reported in favor of a railway terminating at the mouth of the Appalachicola river. In 1842 Mr. ROBINSON was appointed, in connection with Commodores SHUBRICK and CONNER, on a commission to inquire into the best site for the proposed dry-dock in the harbor of New York; and Wallabout Bay was recommended in a report drawn up by Mr. ROBINSON. This was his last professional work, and he retired in 1847 from all active duty.

Though now more than 87 years of age, Mr. ROBINSON is still actively pushing the construction of a railway system laid down by him over fifty years ago. This is the "Metropolitan Route" from Washington, D. C., to Augusta, Ga., which includes the Richmond & Fredericksburg, the Richmond & Petersburg, the Raleigh & Gaston, and the Palmetto Railroads. The latter line, running from Hamlet, N. C., to Cheraw, S. C., was built by Mr. ROBINSON in 1887, and the other missing link is a line between Petersburg, Va., and Ridgeway, N. C., now also under contract. His eldest son, J. M. ROBINSON, is President of the Seaboard Air Line system, and the elder Mr. ROBINSON is heavily interested financially in all of the roads mentioned. He was also the promoter of the Bay Line of steamers, between Baltimore and Norfolk, and holds a majority of the stock, owning besides these securities a large portion of the stock of the Delaware & Chesapeake canal.

Mr. ROBINSON is an Honorary Member of the American Society of Civil Engineers, and of the Engineers' Club of Philadelphia.

We are indebted to Mr. RICHARD B. OSBORNE, C. E., for many years one of Mr. ROBINSON's most trusted assistants, for the data which form the basis of the above sketch.

CORRESPONDENCE.

The Memphis System of Sewerage.

NEWPORT, R. I., April 15, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

An editorial bearing the above heading, which recently appeared in your paper, has been sent to me from Memphis. Will you allow me a few words in reply?

I might object to your way of putting the case, for I did not come "before the country with my proposition to give the fever-stricken and bankrupt city of Memphis a novel and 'model' sewerage system." I read a paper before the American Public Health Association at Nashville, suggesting a modification of sewerage practice. I had no thought or expectation of its early adoption until men from Memphis, who heard it, said it was precisely what that city needed. Afterwards, as an Engineer of the National Board of Health Commission, I did recommend it, and it was adopted by the authorities. It was not yet, in any sense, a proposition "before the country."

I fail to find in any of my writings an announcement that the principal features of the system recommended were "entirely new." After the Memphis work was completed for 1880, I sent a paper to the Sanitary Institute of Great Britain, and Mr. ROGERS FIELD said, in discussion following its reading, that the conditions described "were altogether unprecedented." You also say that early in 1880 I announced that these features "would constitute a perfect system of sanitary sewerage." The only authority I can find for this quotation is that I said in my Nashville paper (1879). "In my judgment, a perfect system of sanitary sewerage for a small town or a large one would be something like the following:" then followed the first suggestion of the details of what afterward became a system. You say that the "proposed system *was to embody*" certain features, among which you quote "an entire absence of man-holes, and the utter disregard of alignment so far as the question of examination or cleaning is concerned." I cannot find that I ever wrote that at all. I did say in my English paper, in describing what the Memphis system *had embodied*, "The most striking departure from ordinary custom and prescription is the entire absence of man-holes and lamp-holes, and the utter disregard of the alignment of the sewer, so far as the question of examination or cleansing is concerned."

You say that considerable experience had already been gained with sewers which substantially excluded rain-water. "Early in the 'fifties' such sewers had been built in England, and by 1878 a number of towns were at least partially supplied with them." Here you have been seriously misled. No sewers had been built in England, at the time stated, which substantially excluded rain-water. The system that came nearest to it was probably that at Tottenham, built in the fifties; but that admitted water from paved courts, and the overflow from water-butts receiving roof water. Rain-water was never "substantially" excluded from sewers until it was done in Memphis.

You refer to a discussion following a paper sent by me to the "Institution of Civil Engineers in London." No paper sent by me on any sewerage system was ever read or discussed before that Institution.

It is proper for me to say that the plan for the sewerage of Memphis included man-holes on lateral sewers; that these had to be omitted because they could not be afforded, and that experience without them led to better devices for accomplishing their effect in the case of small sewers, and I refer as to this to what I subsequently wrote about such omission.

You imply that the view generally held is "that the admission of some storm-water from roofs or paved back yards" is beneficial. In the next paragraph, you say that, in Memphis, the amount of water, necessarily slight, surreptitiously admitted from yards and roofs, in spite of the strictest regulation "made it necessary to build several overflows and relief sewers."

You say that no official review of the actual working of the system appeared before Mr. HARTFORD's paper. Major HUMPHREYS, the very able engineer in charge of the sewers of Memphis, who was giving them constant attention, made a very complete report concerning them in July, 1881, giving really more information about them than is to be found in any later document.

In December, 1882, the city engineer said, "The system, in the main, has so far worked admirably, and has given entire satisfaction."

In 1883, Mr. HERING visited Memphis and found that its sewerage system had been so far changed as to be substantially another system from that which I built, arriving at the conclusion that, with its changes, it had become "as good as any city or town suitable for its application could wish it to be."

Mr. BALDWIN, who had been employed under me in the construction of the work, and who was very familiar

Moncure Robinson

with every part of it, went to Memphis and made a thorough examination of the whole system, making a report concerning it which showed Mr. HERING'S report to be essentially untrue. Mr. BALDWIN'S report was made "official" by the official certificate to the correctness of its statement signed by the city engineer, the superintendent of sewers, the assistant superintendent of sewers, and the chief assistant engineer, these being the only officers who had had to do with the sewers since they were given up by Major HUMPHREY, who also wrote in this connection: "While the liability of the 6-in. pipes to become obstructed seems to me about the only defect of the system, it has the advantage that partial obstructions soon become complete and imperatively demand attention, and there is consequently little danger of the sewers becoming filthy when city authorities are negligent." His letter sustained Mr. BALDWIN'S statements in all respects.

In his report for 1886, the city engineer said: "Thus far no fault can be found with the manner in which the system has worked. The excessive quantity of mud in the water is the chief cause of trouble. The small ¾-in. supply pipes to the flush-tanks become clogged with mud, making it necessary to replace all those in high places with large pipes. With clear-settled or filtered water, all this trouble would cease and the whole system work to a charm."

You publish a report from Mr. HARTFORD to the city engineer, showing certain obvious defects. The first relates to imperfections of the automatic tank introduced nine years ago. Those imperfections were overcome by modifications made in 1883, the improvement being at once made known to the authorities of Memphis and offered to them without charge for royalty. There is a still better tank available now, and it is to be assumed that it will be used. The next defect is that, outside of the district covered by the 4 miles of deep sewers built before 1879, inconvenience has been felt from the fact that the sewers are too shallow to accommodate heating apparatus and elevators in business buildings. In 1879, it was assumed that such occasion for deep sewers would be confined to the 4-mile district, and the financial condition was such that no provision for future possibilities of this character could be made. It is next stated that a gradient of 1 to 50 is rarely attainable for house drains. This statement must have been written somewhat carelessly. In much more than one-half of the cases, the ground at the rear of the house is as high as the ground over the sewer in the alley. The sewers are more than 6 ft. deep and the house drains need be, and generally are, only 2 ft. deep at their upper ends, giving a fall of 4 ft., which is at the rate of 1 in 50 for more than the whole depth of the lot. It is impossible that "quite 2,000 obstructions," occurring in house drains within a year, can be due to lack of gradient. The real cause, like that of the overcharging of some of the sewers, is probably indicated at the end of Mr. HARTFORD'S final report, where he recommends proper skilled inspection of plumbing work. He says, "Bad practice has now become the common practice, and it is clearly attributable to lack of intelligent supervision. Our force is too small to make this. It is certain that poor and illegal work is costing this department a large sum each year for cleaning and repairing sewers, and it is not improbable that it has caused, prematurely, our overcharged mains."

The greatest defect is found in the smallness of the main and sub-main lines. There is sufficient evidence that these lines are too small for the duty that they have to perform, and they must be enlarged sooner or later. This, however, has nothing to do with the merits of the system to which they furnish an outlet.

As evidence that the sewers of Memphis are not yet entirely without merit, I submit the following extract from a letter from Mr. HARTFORD written Oct. 12, 1888:

"Your letter of the 18th ult., addressed to Major MERRIWETHER, was handed to me for reply. Since it was given me I have had a thorough examination of the system made. Every line of sewers, whether of low or high gradient, is thoroughly clean. We have no fouling upon any line, and upon many I am certain that a velocity (mean) of not even 1½ ft. is reached. On one of low gradient (1' in 200') in a distance of 700 ft., the maximum depth of flow is not more than 2 ins. (it is a 6-in. line) or perhaps 3 ins. with the flush; yet even here, where the mean velocity cannot exceed 1.3 ft., the pipe is perfectly clean.

"We have, it is true, occasional stoppages, but they are invariably caused by foreign substances, such as sticks, rags, etc., never by deposit of sewage."

I am very sorry to have taken so much of your space, and I should of course be glad if I were able to say that the Memphis work, done nine years ago, under conditions that were "altogether unprecedented," had been originally, so good and complete as to need no improvement and as to meet with only friendly and honest criticism. As I am denied this satisfaction, I must find such consolation as I can in the fact that that system, essentially unchanged, is now in active operation in between forty and fifty towns of the United States, and that its use is increasing rapidly.

GEO. E. WARING, JR.

Compass with Micrometer Adjustment.

NEW YORK, April 10, 1889

TO THE EDITOR OF ENGINEERING NEWS:—

We take exception to an article on "Compasses with Micrometer Adjustment," published on page 307 of No 14 of your paper. It seems to us that it is hardly fair to designate as "designed by T. A." an instrument which we put on the market here four years ago, and which we describe in our Catalogue [No. 711 page 63] since August, 1887. We have never put this appliance on our Superior Swiss Instruments, as the joints in them are so perfect that they need no such extra adjustment or correction, but we have put it on our best German instruments which are not of as fine quality.

We are not after the glory that is in this, but it seems that, if one of our improvements is copied, a recognized authority like your valuable paper should not credit it to the imitator and ignore the originator.

Yours respectfully, KEUFFEL-ESSER CO.

Passenger Ferry Bridges, N. Y., L. E. & W. R. R.

Hoboken Ferry Co., Superintendent's Office,

HOBOKEN, N. J., April 12, 1889.

TO THE EDITOR OF ENGINEERING NEWS:—

In your issue of April 6 appears an article on the "Passenger Ferry Bridge." A set of cuts are also published, representing the plan of bridges now in use by the N. Y., L. E. & W. R. R. Co., at their slips in Jersey City.

The article, and especially the cuts, convey the idea that these bridges were designed by that company.

These bridges were copied faithfully from the bridges now in use by the Hoboken Ferry Co., which design has been in use for something over forty years, being originally planned by the late ROBERT L. STEVENS.

It is but justice to this company that credit should be given where it belongs, especially as it is universally acknowledged that it is the best type of passenger ferry bridge that has ever been used in the harbor of New York.

I would request you to use this information for the purpose of correcting the impression conveyed by the article referred to. Yours truly,

C. W. WOOLSEY, *Superintendent.*

[We publish with pleasure the above letter, and trust that it will set the matter right with our readers. And we are also pleased to know from so competent an authority that the inventor is no other than the famous ROBERT LIVINGSTON STEVENS to whom we are indebted for so many improvements in steam machinery, the introduction of anthracite coal in steamers, the iron-clad *Dunderberg*, etc. But in justice to the railway company referred to, we should also state that no claim whatever was made to originality of design by any official of that company. The name was attached to the plans in this office in accordance with an office rule when treating of railway appliances, and we alone are responsible for the use made of it.—ED. ENG. NEWS.]

A Short Radius Loop.

Erie & Wyoming Valley R. R. Co.

DUNMORE, Pa., March 29, 1889.

TO THE EDITOR OF ENGINEERING NEWS:—

In answer to C. L. C.'s inquiry, in your issue of March 9, I would say that the enclosed is a tracing of a loop on this road, which is in constant use by all engines and trains and often at a speed of 20 miles per hour.

Passenger engines, yard engines, Moguls and Consolidations, all use it more or less to turn on the radius. I do not consider 310 ft. a limit by any means. The gauge is 4 ft. 8½ ins., the rails 67 lbs., and the elevation 6 ins. There is no guard rail. Yours truly, A. D. B.

[It certainly is not a limit, the curve being only 18½°. The Mexican Railway has many curves of 325 and 350 ft. radius on its line, and for a time, while building a difficult tunnel, used reversed 150-ft. radii successfully for its main line traffic, which then was very small. We must not be understood to advise copying this radius, however, unless in some extreme cases.—ED. ENG. NEWS.]

Bridge Failures in 1888.—Correction.

ALBANY, N. Y., April 11, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

Since the publication in your issue of March 30, of a list of bridge failures in 1888, compiled by me, I have been advised that the accident reported as No. 28 and which occurred on the Gulf, Colorado & Santa Fé railway on Sept. 19 was given erroneously in that it happened on a pile trestle and not on a Howe truss bridge as stated. It should not therefore have appeared in the list. Making this correction reduces the number of bridge accidents during the year to 31, and during 10 years to 284.

Yours truly,

CHAS. F. STOWELL.

Ventilation of Sewers.

BROOKLYN, N. Y., April 2, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

In your issue of March 30 I notice a communication signed O. H. W., of Boston, wherein the writer proposes as a means of ventilating sewers in that city, "that connection be made with a furnace chimney at the State House, Beacon Hill, wherein the gases from the sewers would furnish a good part of the power to do the work," I presume by exhaustion. Would it not be well for O. H. W. to inform himself as to what has been done, before suggesting what should be done? If O. H. W. will but look at the first volume of the Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors, London, 1875, Vol. IV., 1879, he will find that Mr. HEYWARD, still Engineer of the City of London, and Sir JOSEPH BAZELGETTE have experimented sufficiently to justify their complete condemnation of the method as worthless. Indeed, it was scarcely necessary to put the method on trial to the extent which they did; as a slight consideration would show that, while the pressures near the chimney might be excessive, indeed, beyond practicable attainment, yet the velocities induced in the branch sewers, with a combined sectional area of over a hundred times, perhaps more, that of the mains, might be so low as to result virtually in stagnation, on the basis that the pressure would be inversely as the spaces occupied; and this was precisely the result which they reached.

Modern improvements permit of the house-pipes being properly laid and maintained with traps under all fixtures, each ventilated by connections with a main ventilating pipe as large as the soil pipe running parallel with it and extending above the roof, the main soil pipe connecting with the sewer, *untrapped*, thus permitting the sewer to *breathe* through the house pipes unobstructed. This, with the perforated manhole covers at intervals of say every 100 ft., will furnish all needed ventilation of the sewers, if *the latter be properly built*. The perforated manhole cover in the middle of the street, so far from being a nuisance, serves as a warning. If any odor is perceived at the distance of the sidewalk, the indication is that the sewer is obstructed, and is not performing its duty. It should be remembered that the system of city sewerage is a hydraulic machine, and as a machine requires supervision; and no perfection of house drainage is of any worth, if the city mains, into which they discharge, are improperly built or neglected. J. W. A.

A CORRECTION.

Mr. C. E. FOWLER writes that in his note, published in ENGINEERING NEWS of April 6, the expression $1 = \frac{Min.\ B}{Max.\ B}$ should read $1 + \frac{Min.\ B}{Max.\ B}$. The error occurs in the middle column, 36 lines from bottom of page.

Notes, Queries and Answers.

J. L., Aguas Calientes, Mexico, asks: Can you furnish me with an engineer's field-book in the metric system, or any kind of tables that give sines, tangents, and radii in metres?—Trautwine's Pocket-Book contains a table of radii of metric curves, but there is really no necessity of such special tables of any kind. The so-called "foot table" of radii gives also the radius for any unit, 100 of which make the chain. The usual (and only proper) metric chain is 20 metres long, divided into 100 links of 20 centimetres each. Hence a 1° metric curve has *one-fifth* as many meters in it as a 1° foot curve has feet, or $6{,}740 \times 0.2 = 1{,}168$ metres, and so for any other curve. This once learned makes the process of using the foot tables perfectly simple. The metric chain having only 65.6 ft. in it, the length *in feet* of any metric radius is only 0.656 times as much as the length of a foot curve radius of the same degree, or roughly, two-thirds as much.

THE SYSTEM OF WATCH INSPECTION in use on the Louisville & Nashville has been reorganized. Giles Bros. & Co., of Chicago, have been appointed General Inspectors for the whole system with authority to appoint division inspectors at various points. Each employé whose duties require him to observe accurate time must report to the division inspector once a week to have his watch examined and recorded. It is recommended that each employé provide his watch with an Anti-Magnetic Shield.

THE SUMMER COTTAGE ENTERPRISE founded at Twilight Park in the Catskills by Sanitary Engineer CHAS. F. WINGATE, as an outgrowth of the "Twilight Club," seems to have become a decided success. A large number of cottages and lots have been sold and the club house will have to be enlarged to meet the demands for the coming season. It satisfactorily solves the problem of how to secure a summer vacation without the care of housekeeping, yet with all the freedom of your own home.

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EDITORS.

GEO. H. FROST. - - - - - BUSINESS MANAGER.

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Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Engineers' Club, Philadelphia, Pa.—Regular meeting, April 20. Secy., Howard Murphy, 1122 Girard St.

Western Society of Engineers, Chicago, Ill.—Regular meeting, May 1. Secy., John W. Weston, Gaff Building.

American Society of Civil Engineers, New York.—Regular meeting, May 1. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of St. Louis, Mo.—Regular meeting, May 1. "Some New Theories and Experiments on Boiler and Factory Chimneys," Prof. H. B. G le; "Experiments on Settling Water," J. A. Seddon. Secy., Wm. H. Bryan, 709 Market St.

Association of Civil Engineers', Dallas, Tex.—Regular meeting, May 3. Secy., E. K. Smoot, 15 No. Jefferson St.

Engineers' Club of Kansas City, Mo.—Regular meeting, May 6. "Foundations for the Litmfjord Bridge," Otto F. Bonne. Secy., Kenneth Allen, 310 Baird Building.

New England Railway Club, Boston, Mass.—Regular meeting, May 8. "The Compound Locomotive." Boston & Albany passenger station.

Civil Engineers' Club of Cleveland, O.—Regular meeting, May 14. Report on Applied Science. Secy., James Ritchie, Case Library Rooms.

American Society of Mechanical Engineers.—The annual meeting will be held at Erie, Pa., May 14, 15 and 16. Secy., F. R. Hutton, 280 Broadway, New York City.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, May 15. Secy., S. E. Tinkham, City Hall

New York Railway Club.—Next meeting, May 16. Rooms 113 Liberty St., New York City.

Engineers' Society of Western Pennsylvania, Pittsburg, Pa.—Regular meeting, May 21. Secy., S. M. Wickersham, Penn Bldg.

The resignation of Mr. M. N. FORNEY as Secretary of the Master Car Builders' Association ends an official career which has been in the highest degree useful to that body and to the railway public. To Mr. FORNEY, far more than to any other one man, the successful work of the Association may be said to be due, and we believe that practically to him alone was due the credit of its reorganization by the admission of representative members, which has very greatly added to its efficiency and usefulness. Previously to that change, every member had one vote, and one vote only, whether he had 50 cars in charge or 100,000. A natural effect was that a numerical majority, who might not represent five per cent. of the cars in use, could outvote a numerical minority who yet represented three-quarters or more of the cars in the country. The consequence was that the votes of the Association carried little or no moral weight, being always open to the suspicion of such unfairness even when it did not exist, and also that representatives of the larger roads were shy of having any connection with the Association. Mr. FORNEY, by his labors and judicious counsel, first brought the Association up to a point where its discussions commanded respect, or at least, took a leading part in so doing, and then, as we have stated, started and urged the movement for "representative membership" which is now in force, and under which every road has a right to appoint one representative member who has one vote for every 1,000 cars on the road; such members being in addition to the original membership open to any master car-builder, and giving him a single vote. The result was exceedingly fortunate. At the last meeting (or shortly after it) there were 91 representative members, representing 755,743 cars, or having 756 votes, and 139 active members in addition. As the total number of cars in the country at this time, according to *Poor*, was only 963,223, this shows that the Association practically speaks for the whole ear interest of the country.

THAT the action of this or any other like body should be always wise is too much to expect, and still less is such invariable wisdom to be expected of an individual. The action of the Association has been unfortunate and unwise in respect to some of its standards, as for instance in attempting to impose one single axle and one single brake shoe and head (not to mention some other single standards) upon the entire rolling stock of the United States, when two or three established and recognized standards for each, from which every one could take his choice, would have accomplished all needful ends in doing away with irrational diversity and simplifying repairs, while yet leaving some room for improvement and individual choice. For lack of such room for choice many of the M. C. B. standards are still more honored in the breach than the observance. Still less was the M. C. B. action in regard to a standard wheel-tread to be commended. On very trifling evidence as to facts, and that mostly erroneous, and in accordance with a theory which is now generally admitted to be unsound, a standard was adopted which, it admits of little doubt, was in respect to "fitting the rail" precisely the opposite of what was desirable, and still worse, which attempted to establish uniformity where it was in no way important to have it. But in the main, immense good has been accomplished by the M. C. B. Association, and no one man has done as much to aid to that end as Mr. FORNEY. This has been generally felt in the Association, and but for that feeling we imagine that Mr. FORNEY would long since have closed his official career in that body, as he has several times before tendered his resignation.

THE most serious features of the Nicaragua canal project, in a contracting and financial sense, is the great rock-cut at the eastern divide, 3 miles long and averaging 120 ft. deep by 80 ft. wide on the bottom, containing in all some 7,000,000 cu. yds. of material, or say 440 cu. yds. per lineal foot. There is no precedent for such an enormous cut, and it has been assumed that four years at least would be necessary to complete it, while many question the possibility of doing it in that time. The great rock-cut which we illustrate and describe elsewhere, if it may be relied on as a precedent, would go far to relieve these doubts. From that cut 215,000 cu. yds. have been removed in 20 mos. within a lineal distance of 450 ft., or nearly 500 cu. yds. per lineal foot, and this by day work only, with a force of 150 men, or one man per yard of center line, by four cable hoisting plants only, or say one per 100 ft., and practically at the rate of about 4,000 cu. yds. per month per cable when working full time and with full force. Equal efficiency cannot be expected in tropical Nicaragua and temperate New York; but neglecting for the moment this very serious difference, a work, conducted with equal efficiency, and with a cable hoisting plant for every 100 ft. of center line, would at the rate of 4,000 cu. yds. per month extract the necessary cube of 44,000 cu. yds. *in just* 11 *months* of solid work, and this without night work; while the force necessary to accomplish this end, if the New York example were admissible as a precedent, would be about 5,300 men with 160 cable hoisting plants, or about 33 men per plant and per 100 ft. This is not so large a number as to seem difficult of attainment, or to cause the men to be in each others' way, even if increased by a considerable percentage to allow for tropical inefficiency; and we fully believe that there are men in this country who can and will undertake to parallel this record if afforded the opportunity, and if the contracting wheat be winnowed from the chaff by some other and safer method than "lowest bid" and "inflocence," so that those men who really understand from experience how to handle such work may have a fair chance.

THE order of Mayor GRANT authorizing the removal by force of the poles and wires in the subway district of this city, sounds a little arbitrary, and the cutting of electric circuits has darkened some of our main thoroughfares and is to that extent a nuisance to pedestrians. But the poles and wires are a greater nuisance and their number has grown with time and service demands, until the evil has assumed proportions that seriously mar the appearance of our city and amount to a constant threat to life and property. The subways may be as imperfect as some of the electric light companies say they are, and no one will claim that they are the best that could be devised; but the only possible way to prove the position of either side in this controversy is to put the wires into the subways, and thus practically prove their efficiency or their unfitness for the purpose intended. This disposal of the matter is better than the most eloquent pleading or any amount of learned discussion as to why the wires should or should not work underground. The people have had enough of talk and now want results. We must have efficient subways of some kind, and if the rather cheap and temporary affairs now buried under some of our streets will not properly perform the duty expected of them the sooner we find it out the better, and the more rapid will be the steps taken towards some more substantial and perfect system of handling the many appliances, besides wires, that now lie buried at random under our pavements. This disposal of wires and pipes is a very difficult problem to properly solve and any radical and efficient system will be enormously costly in the start. But it is also a rapidly growing evil, and every cheap makeshift and every year's delay will only add to the cost of that reconstruction on a proper basis that must some day inevitably come. Cutting down the poles is a radical method of ridding the streets of a nuisance; but inasmuch as the plain tendency of this action is to stop talk and force practical results of some kind, Mayor GRANT is to be commended for his decision.

An engineer of experience, just returned from Panama, where he personally examined the present status of the undertaking, reports to us that it now offers a pitiful spectacle.

A hundred men or so are still going through the form of "prosecuting the work," from a wholesome respect for the provision of the concessions by which a six months' suspension of work (we believe it is) causes a forfeiture of the concessions and of all work and plant to the Government of Colombia, which is reported to be already considering whether the present status does not amount to practical suspension of the work. But apart from this corporal's guard of perfunctory toilers, the whole canal is deserted and beginning to cover itself with tropical vegetation, while it is yet strewn from end to end with immense quantities of plant, standing out, unsheltered and uncared-for, wherever they happened to be when the work was suspended. In a few cases, rows of a dozen or more locomotives will be found under cover; but great numbers even of the locomotives are standing out in the open air, and are already overgrown with vines and other vegetation; while immense trains of dump cars, cranes, derricks, excavators, etc., are exposed entirely without protection, and a large part of them are already almost worthless. The ten miles or so of "finished" canal, excavated by the American dredges, was so filled up by the last flood of the Chagres, that although a tug of 8-ft. draft can still get up it, it is apt to touch bottom at several points before its trip is over, and much work above this section has been effaced in the same way. The Panama Railroad has been running free trains to aid in bringing off the workmen, many of whom before they started home were in almost a starving condition, and so reduced as to be unable to mount the train without aid. The thousand miles or so of construction rails, which would otherwise be a permanently available item, are so very high and narrow-based as to be quite unsuitable for such use. There is not the slightest probability that work will ever be resumed on the canal.

THE German brake tests, recorded elsewhere, show very good and extraordinarily uniform results, the percentage of efficiency in emergency stops varying but slightly from a little above 10 per cent. of the weight on the braked wheels. An ideally perfect brake system would realize about 24 per cent. and this amount has been actually realized in one vehicle only on the earth's surface,—an experimental car fitted up with an apparatus devised by Mr. WESTINGHOUSE to vary the pressure with speed so as to keep the coefficient of retardation constant at about 0.24, that being the rate which just fails of skidding the wheels. But as the coefficient of brake pressure is much lower at high speeds, falling sometimes to 0.09 or even 0.07, unless we have a brake pressure of twice the load on wheels, or more, we cannot get a retardation of 0.24 when brakes are first applied; and unless we can reduce this pressure greatly as speed falls, we shall soon skid the wheels. Hence with constant pressure (or nearly constant, the leakage reduces it slightly) we can never hope to get more than 14 to 16 per cent. efficiency, and this was actually realized in a number of the WESTINGHOUSE tests of two years ago. Even this involves very considerable danger of skidding wheels, and the German tests represent about the last degree of practical efficiency which seems reasonably attainable without varying pressure or danger to the wheels. It would be well if all trains in actual service were able to realize even a considerably less percentage: few can realize as much.

It will be observed also that, with the short trains of 18 cars, there was only a moderate advantage found from the new quick-acting valves. With the long train of 50 cars, the newer form only was tried, which was fortunate, as otherwise the shocks at rear of train would have been terrific, and highly dangerous to the comparatively light German cars.

THE Springfield newspapers are now on what seems to be the right track for satisfactorily solving the much mooted question of the bridge over Main St., in that city. Both the *Republican* and the *Union* illustrate plans for iron or steel bridges, some with hinged arches, and one design of plate girders as suggested by us last week. And we are pleased to see that the designs selected altogether omit the 12-ft. screen, regarding it as a useless and unnecessary precaution. As before remarked, it is the noise of passing trains that will be the most likely to alarm horses, and in this connection the suggested use of the iron ballast troughs, employed in the Berlin elevated system, will practically reduce this noise to a minimum. To our mind, the girder plan is still the best, as least obstructing the roadway beneath. The rise is too light for an effective metal arch, and with any arch the footways would be more or less crowded. The design given in the *Union* shows that a good arch effect can be secured with the girder bridge, without any infraction of structural laws.

The Water-Works of the Far West.

Under this general term we include the three groups of Northwestern, Southwestern, and Pacific, which include all the trans-Mississippi States and Territories except Louisiana, which is bisected by the Mississippi (but with most of its area on the western side of the river) and included with the South-Central group.

If we exclude from this vast area the most easterly tier of States in it, Minnesota, Iowa, Missouri, and Arkansas, the remainder constitutes somewhat more than half the total area of the United States, but until recently it has been very thinly populated, as the following figures show:

	Area. 1 = 1,000,000 sq. m.	Population of U. S. Census. (1 = 1,000) 1880	1870	1860	1850
Minn., Ia., Mo., Ark	256.0	5,378	3,339	2,464	1,000
Far West (west of above States)	1,862.1	4,943	2,311	1,364	391
Total of 3 Far West groups	2,118.1	10,321	6,150	3,828	1,481
Total U. S	3,026.5	50,155	38,558	31,443	23,192
PERCENTAGES.			Population.		
	Area.	1880	1870	1860	1850
Minn., Ia., Mo., Ark	8.5	10.7	10.0	7.8	4.7
West of do	61.5	9.8	6.0	4.3	1.7
Total of 3 Far West groups	70.0	20.5	16.0	12.1	6.4
Total U. S	100.0	100.0	100.0	100.0	100.

From this it will be seen that the population of this entire far west region, including 70 per cent. of the whole area of the United States, was in 1880 a trifle over *one-fifth* of that of the whole country, and this population was about equally divided between the tier of the four most easterly States bordering on the Mississippi and the vast area west of it, nearly eight times as large. At the present time, assuming the population to be increasing on that of the rest of the United States about in the past ratio, the far West as a whole should include about a quarter of the United States population, but not more.

This being so, it is instructive to compare with the preceding figures the water-works statistics for this region, which will be seen from the accompanying Tables 1, 2, and 4 to stand as follows.

	Pop. on W. W.'s [1 = 1000]	No. water-works	Cost [1 = $1,000]	Revenue $1,000]	Miles mains	No. taps.	No. meter
Minn., Ia., Mo., Ark	977	110	34,211	3,083	1,466	87,467	12,40
West of do	1,075	280	59,120	5,592	3,472	144,753	15,04
							2
Total Far West	2,052	490	93,331	8,675	4,878	232,220	27,45
Total Eastern	12,806	1,177	338,894	30,688	19 379	1,846,524	141,06
Total U. S	14,858	1,667	432,225	39,363	24,257	2,089,544	168,518
PERCENTAGES.							
Minn., Ia., Mo., Ark	6.6	6.6	7.9	7.8	5.8	4.2	7.4
West of do	7.2	22.8	13.7	14.2	14.3	6.9	8.9
Total Far West	13.8	29.4	21.6	22.0	20.1	11.1	16.3
Total Eastern	86.2	70.6	78.4	78.0	79.9	88.9	83.7
Total U. S	100.0	100.0	100.0	100.0	100.0	100.0	100.1

It will be seen at once, by studying these statistics, that as between the Minnesota-Arkansas tier of States and the great area west, the two having about equal population, the latter is vastly the more progressive, having over three times as many water-works and nearly three times as many miles of mains as the easterly tier of States. The indications from these facts are very strong that the extreme far West has been growing with great rapidity since the census of 1880; much more so than is generally imagined.

This is still more evident from a comparison of the far West as a whole and the eastern United States. There is at most something like one-quarter of the United States population in that region, and that the newest and most unsettled part of it, busily occupied in the heavy work of subduing a continent. It would be entirely natural that the water-works should be disproportionately few and cheap in that region, especially in view of the small number of large towns in it; yet as a matter of fact nearly 30 per cent. of the water-works are out there, and even the capital invested is in full proportion to the Eastern United States.

Neglecting the Mississippi tier of States (Minnesota-Arkansas) altogether, the contrast between the far West and the East becomes still more remarkable. That tier averages closely with the easterly region. The extreme far West, west of it, should contain now a little over 12½ per cent. of the United States population, judging by past ratios of growth, and a much smaller proportion than that (see Table 6) of the urban population in towns of 4,000 or over. Yet it has already 23 per cent. of the water-works, and 14 per cent. of the cost, revenue, and miles of mains. Making all allowances for the unbounded enterprise of this region, these statistics afford very strong evidence that the 1890 census will show an enormous influx of population into this section since 1880, far beyond past ratios.

In all three of these groups there are only three towns which had 4,000 population or over in 1880 which have no water-works reported, and at two of these works are now projected. These towns are:

	Pop'n 1880
Creston, Iowa	5,081 (works projected.)
Warrensburg, Mo	4,949
Brownsville, Texas	4,938 (works projected.)

TABLE 1—F-G-H.

NORTHWESTERN, SOUTHWESTERN AND PACIFIC STATES WATER-WORKS.—SUMMARY BY DATES OF CONSTRUCTION.

TABLE 1—F. NORTHWESTERN STATES.

Year.	Iowa	Minn.	Kans.	Neb.	Dak.	Wyo.	Mont.	Total.
1867	.....	1	.....	.....	.....	1	.....	1
1870	.....	1	.....	.....	.....	.....	.....	2
1871	2	.....	.....	.....	.....	.....	.....	2
1872	.....	.....	.....	.....	.....	.....	.....	.....
1873	.....	.....	.....	.....	.....	.....	.....	.....
1874	2	.....	.....	.....	.....	.....	.....	2
1875	1	.....	.....	.....	.....	1	.....	2
1876	4	1	(1)	.....	.....	.....	.....	(1) 5
1877	1	.....	.....	.....	.....	.....	.....	1
1878	4	.....	.....	.....	.....	.....	.....	4
1879	1	1	.....	.....	1	.....	.....	3
1880	.....	1	.....	1	1	1	.....	4
1881	4	1	.....	1	.....	.....	.....	6
1882	3	2	7	.....	1	.....	.....	13
1883	7	5	4	.....	1	.....	2	19
1884	9	3	3	1	4	.....	.....	20
1885	1	.....	4	1	3	.....	.....	9
1886	3	.....	8	5	6	.....	.....	22
1887	5	2	17	11	3	.....	1	39
1888	4	2	24	23	5	1	3	62
Unk'wn.	2	.....	3	.....	1	1	1	8
Total.	13	20	(1) 71	42	26	5	7	(1) 224

Year.	Mo.	Ark.	Tex.	Colo.	N. M.	Total.	Wash.	Ore.	Cal.	Ariz.	Nev.	Utah.	Idaho.	Total.
1821-30	1	.....	.....	.....	.....	1	.....	.....	1	.....	.....	.....	.....	1
1831-40	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
1841-50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1851	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1852	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1853	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	2
1854	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1855	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1856	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1857	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
1858	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	1
1859	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	2
1860	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1861	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
1862	.....	.....	.....	.....	.....	.....	.....	1	2	.....	.....	.....	.....	3
1863	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1864	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
1865	.....	.....	.....	.....	.....	.....	1	.....	3	.....	1	.....	.....	5
1866	.....	.....	.....	.....	.....	.....	1	.....	1	.....	.....	.....	.....	2
1867	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
1868	.....	.....	.....	.....	.....	.....	1	.....	1	.....	.....	.....	.....	2
1869	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	.....	.....	2
1870	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	2
1871	1	.....	.....	.....	.....	1	.....	1	3	.....	3	.....	.....	7
1872	.....	.....	.....	1	.....	1	.....	.....	1	.....	.....	.....	.....	1
1873	1	.....	.....	.....	.....	1	.....	.....	3	.....	1	.....	.....	4
1874	.....	.....	.....	1	.....	1	.....	.....	3	.....	1	1	.....	5
1875	.....	.....	1	2	.....	3	.....	.....	4	.....	.....	.....	.....	4
1876	.....	.....	1	.....	.....	1	.....	.....	5	.....	.....	.....	.....	5
1877	.....	.....	.....	.....	.....	.....	.....	.....	(1) 1	.....	1	.....	.....	(1) 2
1878	.....	1	1	.....	.....	2	.....	.....	(1) 2	.....	.....	.....	.....	(1) 2
1879	.....	.....	2	4	.....	6	.....	.....	1	.....	.....	.....	.....	1
1880	3	.....	.....	2	.....	5	.....	1	2	.....	.....	2	.....	5
1881	1	.....	.....	2	1	4	.....	.....	1	1	.....	.....	.....	2
1882	1	1	2	4	1	9	.....	1	3	1	1	1	1	8
1883	3	.....	6	4	1	14	.....	1	3	.....	.....	.....	.....	4
1884	.....	1	13	2	.....	16	2	1	1	1	.....	.....	1	6
1885	7	1	4	.....	.....	12	.....	.....	2	.....	.....	.....	1	3
1886	3	.....	4	3	1	11	.....	3	2	.....	.....	.....	.....	5
1887	2	2	3	5	2	14	.....	3	6	.....	.....	.....	1	10
1888	(1) 3	4	13	8	1	(1) 29	3	4	12	1	1	.....	.....	21
Unk'n.	.....	.....	1	(1) 2	.....	4	.....	.....	3	.....	1	.....	.....	4
Total.	(1) 26	10	51	(1) 40	7	(1) 135	8	17	(2) 78	4	11	4	4	(1) 2.6

The number of works projected, with fairprospects of construction, in the different States are:

Iowa	8	Missouri	2	Washington	4
Minn	1	Arkansas	2	Oregon	2
Kansas	6	Texas	8	California	3
Nebraska	3	Colorado	5	Arizona	..
Dakota	3	N. Mexico	..	Nevada	..
Wyoming	1			Utah	—
Montana	—	Total S. W	17	Idaho	..
					—
Total N. W	22			Total Pacific	9
Total of Far West Groups					48

Total Eastern (N. Eng., 28, Middle, 19, So. Atl.and So. C., 40, No. Cen., 21.) 105

This makes a total of 153 works now known to be projected, or about 9.3 per cent. of the existing works, the two Southeasterly groups showing the most progress in this respect, having works numbering 31.2 per cent. of its existing works projected. The three far West groups together have only 10 per cent.

It will be seen from Tables 1 and 2 that before 1861 there were only 9 water-works in this whole region, 7 of them in California; and even up to 1871 there were only 31. The remaining 459 have all been built since, and all but 73 of them (or 386) since 1880. Thus only 104 water-works existed prior to 1881, while 386 have been built in the years 1881-8 inclusive.

Table 6 gives the population statistics, which mostly explain themselves. The necessity of using census records which are already nine years old, for a rapidly growing section like this, is very unfortunate, but as the ratio of growth between 1870 and 1880 is given for each State and group, the evil is minimized. The "population on water-works" being likewise that of 1880, the ratio of it to total city population should remain about the same, however, and the very large ratio which appears in the far West (129.2 per cent. against 113.0 per cent. east of the Mississippi) is rather an evidence of superior enterprise than of defective census records.

Discussion of Table 7, showing the classifications of water-works by size of towns, we postpone until we summarize the works of the whole United States.

TABLE 2-F-G-H.

NORTHWESTERN, SOUTHWESTERN AND PACIFIC STATES WATER-WORKS.—SUMMARY OF CONSTRUCTION BY STATES AND HALF DECADES.

TABLE 2-F.—NORTHWESTERN STATES.

DATE.	Ia.	Minn.	Kan.	Neb.	Dak.	Wyo.	Mont.	Total.
1867-70	.....	2	.....	.....	.....	1	.....	3
1871-75	5	.....	.....	.....	.....	1	.....	6
1876-80	10	3	(1) 1	.....	2	1	.....	(1) 17
1881-85	24	11	18	3	9	.....	2	67
1886-89	12	4	49	39	14	1	4	123
Unknown.	2	.....	3	.....	1	1	1	8
Totals.	53	20	(1) 71	42	26	5	7	(1) 224

TABLE 2-G.—SOUTHWESTERN STATES.

DATE.	Mo.	Ark.	Tex.	Colo.	N. M.	Total.	Grand Total 3 Groups.
							[Prior to '71] 31
1830	1	.....	.....	.....	.....	1	
1871-75	2	.....	1	4	.....	7	34
1876-80	3	1	4	6	.....	14	(3) 46
1881-85	12	3	25	12	3	55	145
1886-89	(1) 8	6	20	16	4	(1) 54	(1) 213
Unknown.	.....	.....	1	3	.....	4	16
Totals.	(1) 26	10	51	41	7	(1) 135	(4) 485

TABLE 2-H.—PACIFIC STATES.

DATE.	Wash.	Ore.	Cal.	Ariz.	Nev.	Utah.	Idaho.	Total.
1821-30	.....	.....	1	.....	.....	.....	.....	1
1831-40	.....	.....	1	.....	.....	.....	.....	1
1841-50	.....	.....	.....	.....	.....	.....	.....	.....
1851-55	.....	.....	2	.....	.....	.....	.....	2
1856-60	.....	1	3	.....	.....	.....	.....	4
1861-65	1	1	7	.....	1	.....	.....	10
1866-70	2	.....	6	.....	1	.....	.....	9
1871-75	.....	1	14	.....	5	1	.....	21
1876-80	.....	1	(2) 11	.....	1	2	.....	(2) 15
1881-85	2	3	10	3	1	1	3	23
1886-89	3	10	20	1	1	.....	1	36
Unknown.	.....	.....	3	.....	1	.....	.....	4
Totals.	8	17	(2) 78	4	11	4	4	(2) 126

TABLE 4 F G-H.

NORTHWESTERN, SOUTHWESTERN AND PACIFIC STATES WATER WORKS.—SUMMARY BY STATES OF THE MAIN STATISTICS GIVEN IN TABLE 3-F-G-H.

TABLE 4-F.—NORTHWESTERN GROUP.

STATE.	Pop'n on Water-Works 1880 census.	No. of works.	Present Finances. Cost.	Present Finances. Revenue.	Miles of Mains.	Number of Taps.	Number of Hydr'ts.	Number of Meters.
Iowa	262,396	53	6,154,127	606,306	352	15,226	2,535	1,421
Minnesota	147,866	20	5,484,151	502,885	345	15,379	3,205	558
Kansas	129,916	(1) 71	4,176,200	412,649	311	11,134	2,121	513
Nebraska	89,850	43	4,596,800	367,860	247	7,491	2,215	468
Dakota	23,723	26	1,125,444	111,185	92	3,178	479	467
Wyoming	8,695	5	483,000	27,500	44	1,060	176	.....
Montana	9 587	7	577,000	76,600	47	2,040	230	.....
Total No. W'n	672,033	(1) 225	22,596,732	2,104,645	1,438	15,538	11,411	3,447

TABLE 4-G.—SOUTHWESTERN GROUP.

Missouri	534,896	(1) 26	21,452,561	1,667,459	645	53,888	5,736	3,240
Arkansas	31 424	10	1,119,767	106 495	64	2.974	482	88
Texas	166 407	51	5,367,300	689 095	465	17,815	3,086	911
Colorado	90,188	(1) 40	3,717,829	415,204	270	13,443	1,505	174
New Mexico	20,556	7	627,000	89,580	54	1,636	183	12
Total So. W'n	843,471	(2) 134	32,284,457	2,987,833	1,498	89,756	10 992	4,425

TABLE 4-H.—PACIFIC GROUP.

Washington	10,395	8	573,600	65,800	66	2,040	228	37
Oregon	34,764	17	983,000	181,500	115	5,062	279	54
California	436,608	(2) 78	31,856,897	2,853,141	1,561	71,732	3,936	9,784
Arizona	9,816	4	665,000	52,500	19	1,555	103	48
Nevada	30,689	11	4,082,740	35 [illegible]36	127	4,196	397	30
Utah	13,769	4	541,000	48 648	43	2,627	232	1
Idaho	.....	4	48,000	10,920	11	345	33	1
Total Pacific	536,041	(2) 126	38,450,237	3,575,759	1,942	87,926	5,047	9,945
Total Far W'n	2,051,545	490	93,331,426	8,668,237	4,878	292,220	27,450	17,817
Total Eastern	12,806,067	1,176	338,894,120	30,688,024	19,379	1,656,524	141,061	89,443
Total U. S.	14,857,612	1,666	432,225,546	39,363,281	24,257	2,089,544	168,511	107,260

TABLE 5-F-G-H.

NORTHWESTERN, SOUTHWESTERN AND PACIFIC STATES WATER-WORKS. — SUMMARY BY DATES OF FIRST CONSTRUCTION OF THE MAIN STATISTICS OF ALL NORTHWESTERN, SOUTHWESTERN AND PACIFIC STATES WATER-WORKS, AS GIVEN IN TABLE 3-F-G-H.

NORTHWESTERN STATES.

DATE.	Present pop'n of water-works.	No. of works.	Present Finances. Cost.	Present Finances. Revenue.	Miles of Main.	Number of Taps.	Number of Hydrants.	Number of Meters.
1867-70	91,046	3	3,406,651	345,674	221	11,805	2,302	477
1871-80	211,059	(1) 14	5,358,500	518,266	273	14,220	2,271	1,430
1881-85	243,911	79	9,448,887	888,626	516	21,088	3 822	1,459
1886-88	116,365	124	4,182,094	339,779	379	7,952	2,897	80
Unk'wn	9,652	8	200,000	12,300	19	473	119	1
Totals.	672,033	(1) 227	22,596,732	2.104,645	1,408	55,538	11,411	3,447

SOUTHWESTERN STATES.

18 0-50	350,518	1	13,000,000	920,000	315	34,022	3,197	2 143
1851-60	.....	.....	.....	.....	.....	.....	.....	.....
1861-70	.....	.....	.....	.....	.....	.....	.....	.....
1871-80	267,915	21	10,486,000	1,210,239	482	33.721	3 392	1,360
1881-85	142,395	55	5,465,036	511,264	412	15,847	2,271	763
1886-89	77,661	(1) 54	3,279.421	336.530	282	6,016	2,055	159
Unk'wn	4,982	(1) 3	84,000	9,800	7	150	77	.....
Totals.	843,471	(2) 134	32,284,457	2,987,833	1,498	89,756	10,992	4,425

PACIFIC STATES.

1821-50	25,060	2	450,000	143,000	46	5,260	387	.....
1851-60	263,310	6	17.653,000	1,498,800	285	28,845	1,595	8,542
1861-70	94,955	19	7,292,800	725,103	513	21,170	722	306
1871-80	90,772	(2) 36	7,408,145	750,816	537	21,334	1,297	871
1881-85	37,827	23	2,603,879	282,400	311	6,917	407	114
1886-89	14,092	36	2,914,413	159.640	240	4,060	568	22
Unk'wn	10,025	4	128,000	16,000	10	340	71	.....
Totals.	536,041	(2) 126	38,450,237	3,575,759	1,942	87,926	5,047	9,945

GRAND TOTALS, NORTHWESTERN, SOUTHWESTERN AND PACIFIC STATES.

1821-50	375.578	3	13,450,000	1,063,000	361	39,282	3,584	2,143
1851-60	263,310	6	17,653,000	1,498,800	285	28 845	1,595	8,542
1861-70	186.001	22	10 699,451	1,070,777	734	32,975	3,024	873
1871-80	5 9,746	(3) 70	23,222,645	2,479,321	1,292	69,275	6,960	3,061
1881-85	424.133	157	17,517,802	1,682,290	1,269	43,852	6,500	2,336
1886-89	208,118	(1) 214	10,376,528	835,949	901	18,028	5,520	261
Unk'wn	24 659	(1) 15	412,000	38,100	36	963	267	1
Totals.	2,051,545	(5) 485	93,331,426	8,668,237	4,878	233,220	27.450	17,817

TABLE 6—F-G-H.

NORTHWESTERN, SOUTHWESTERN AND PACIFIC STATES.—POPULATION STATISTICS IN RESPECT TO WATER-WORKS.

[The "town population" is in towns of 4,000 inhabitants or over.]

STATES.	Total Population. 1870	1880	Inc. per cent.	Urban Population 1880.	Per cent. of total.	Popula'n on Water-works, 1888. Total by 1880 Census.	P. C. of Total pop'n.	P. C. of Urban p'p'n.
TABLE 6 F. NORTHWESTERN GROUP.								
Iowa	1,194,020	1,624,615	36.0	201,200	12.4	262,396	16.2	129.5
Minnesota	439,706	780,773	77.5	129,567	16.6	147,806	18.9	114.1
Kansas	364,399	996,096	173.3	84,907	8.5	129,916	13.1	153.3
Nebraska	122,993	452,402	267 8	51,879	11.5	89,850	19.9	173.4
Dakota	14,181	135,177	853.2	.....	.....	23,723	17.5	.....
Wyoming	9,118	20,789	127.9	.....	.....	8,695	41.7	.....
Montana	20,595	39,179	90.1	.....	.....	9,587	24.5	.....
Total N. W.	2,165,012	4,049,011	87.1	468,153	11.5	672,433	16.6	143.5
TABLE 6-G. SOUTHWESTERN GROUP.								
Missouri	1,721,295	2,168,380	25.9	505,903	23.3	534,896	24.7	106 0
Arkansas	484,471	802,525	65.6	13,138	91.6	31,424	3-9	240.0
Texas	818 579	1,591,749	94.4	115,396	7.2	166,407	10-5	144.0
Colorado	39,864	194 327	387.4	59,715	30 7	90,188	46 3	151.2
New Mexico	91,874	119.565	30.1	6 635	5.5	20,556	17.2	310.0
Total S. W.	3,156,083	4,876,546	54.5	700,787	14.4	843 471	17.3	120.4
TABLE 6-H. PACIFIC GROUP.								
Washington	23,955	75,116	213.5	.....	.....	10,395	13 8	.....
Oregon	90 923	174,768	92.2	17,577	10.0	34 764	19.8	197.5
California	560,247	864,694	54.3	344,004	39 8	436,508	50 5	127.0
Arizona	9,658	40.441	318.7	7,007	17.4	9,816	24.3	140.2
Nevada	42.491	62,266	46.5	24,884	38.4	30 689	49.2	128.4
Utah	86 786	143,963	65.8	26,837	18.6	13,769	9.6	51 2
Idaho	14 999	32,610	117.4	.....	.....	.....	.....	.....
Total Pacific	829,059	1,393,857	68.2	419,309	30.1	536,041	38.4	127.8
Total Far West	6,150 154	10 319,414	67.7	1,588,249	15.4	2,051,545	19.9	129.2
Total Eastern	32 408.217	39 836,379	24.2	11,317,861	28.4	12 906,067	32.1	113.0
Total U. S	38,558,371	50,155,783	30.1	12,906,110	25.7	14,857 612	29.6	115.0

TABLE 8—F-G-H.

NORTHWESTERN, SOUTHWESTERN AND PACIFIC STATES WATER-WORKS.—COST AND REVENUE PER HEAD, TAP, MILE OF MAIN, ETC.

STATE.	Cost per head on water-works.	Cost per mile of main.	Cost per tap.	Revenue per head on w'te w'ks	Revenue per mile of main.	Revenue per tap.	Population on water works. per tap.	Population on water works. per meter.	P. C. rev. to cost.
TABLE 8—F. NORTHWESTERN GROUP.									
Iowa	25.40	17,450	403	2.31	1.720	39.70	17.2	185	9.82
Minnesota	37.00	15,900	356	3.58	1.460	32.70	9.6	278	9.18
Kansas	32.10	13.200	375	3.17	1,324	37.00	11.7	253	9.87
Nebraska	51.10	18,600	614	4.09	1,498	49.20	12.0	192	8.00
Dakota	47.40	12,220	354	4.66	1.210	34.40	7.5	51	9.89
Wyoming	55.50	10,980	443	3.16	625	28.25	8.0	.....	5.69
Montana	60.20	12,250	283	8.10	1,630	37.50	4.7	.....	13.28
Av. No. W'n	33.60	15,660	406	3 13	1,461	37 90	12-1	195	9.31
TABLE 8-G. SOUTHWESTERN GROUP.									
Missouri	40.10	33.330	398	3.11	2,580	31.00	9.9	166	7.76
Arkansas	35.70	17,500	376	3.39	1,665	35.70	10.5	357	9.50
Texas	32.30	11,550	301	4.14	1,480	38.65	9.3	183	11.82
Colorado	41.30	13,780	237	5.15	1,722	51.20	6.7	519	12.48
New Mexico	30.40	11,600	383	2.89	1,110	36.40	12.6	1710	9.49
Av. So. W'n	38.25	21,580	359	3.55	2,000	33.25	9.4	190	9.29
TABLE 8-H. PACIFIC GROUP.									
Washington	55.00	8,680	282	6.31	658	32.25	5.1	281	11.45
Oregon	29.10	8.550	181	5.38	1,578	33.90	6.5	6.2	18.42
California	72.30	20,200	440	6.54	1,830	40.00	6.1	45	9.08
Arizona	67.70	35.000	427	5.35	2.760	33.70	6.3	264	7.89
Nevada	133.00	32,100	973	11.50	2,780	84.20	7.3	1534	8.65
Utah	39.25	12,600	200	3.53	1,130	18.00	5 1	.....	8.99
Idaho	.....	4,363	139	.....	1.000	31.60	.....	.....	22.72
Av. Pacific	71.80	19,800	438	6.68	1,838	40.70	6.1	84	9.29
Av Far Western	45.45	19,150	401	4.23	1,778	37.30	8.8	115	9.30
Av. Eastern	26.45	17,500	184	2.40	1,583	16.60	6.95	143	9.06
Av. U. S.	29.15	17,800	207	2.65	1,620	18.80	7.11	138½	9.11

TABLE 10 F G H.

NORTHWESTERN, SOUTHWESTERN AND PACIFIC STATES WATER WORKS—SOURCES OF SUPPLY.

[Some works have a double source of supply, which increases the total for some States.]

STATE.	S'rface	Sp'ngs	Brook	River	Lake	Creek	Wells	Unk'n	T'tal
Iowa	3	3*	.....	14	.....	2	29	4	55
Minnesota	.....	2	.....	8	4	1	5	.....	20
Kansas	3	2	.....	18	.....	6	39	6	74
Nebraska	1	.....	.....	9	.....	2	28	6	46
Dakota	.....	3	.....	8	2	1	11	1	26
Wyoming	.....	1	.....	2	.....	1	.....	1	5
Montana	.....	.....	1	3	.....	1	1	1	7
Total No. W'n.	7	11	1	62	6	14	113	19	233
Per cent	3.0	4.7	0.4	26.6	2.6	6.0	48.5	8.2	100.0

* Dubuque draws water from an abandoned mining tunnel, classed as spring.

Missouri	2	1	.....	23	.....	1	3	.....	30
Arkansas	.....	2	.....	6	.....	.....	3	.....	11
Texas	1	8	.....	23	1	3	20	1	57
Colorado	3	4	2	12	1	12	5	1	40
New Mexico	1	2	.....	2	.....	.....	4	.....	9
Total So. W'n.	7	17	2	66	2	16	35	2	147
Per cent	4.8	11.5	1.4	44.8	1.4	10.9	23.8	1.4	100.0
Washington	.....	3	.....	1	1	2	.....	1	8
Oregon	.....	4	.....	9	.....	1	2	1	17
California	3†	14*	5	22	3	11	26	1	85
Arizona	1	.....	.....	1	.....	1	1	.....	4
Nevada	.....	5*	1	2	.....	3	.....	1	11
Utah	.....	.....	1	2	.....	1	.....	.....	4
Idaho	.....	1	1	1	.....	1	.....	.....	4
Total Pacific	4	27	8	38	4	19	29	4	133
Per cent	3.0	20.3	6.0	28.6	3.0	14.3	21.8	3.0	100.0
Total Far West.	18	55	11	166	12	49	177	25	513
" Eastern	84	208	93	250	138	87	244	27	1,130
Per cent. West.	3.5	10.7	2.1	32.4	2.3	9.6	34.5	4.9	100.0
" East.	7.4	18.4	8.2	22.1	12.2	7.7	21.6	2.4	100.0

* Two of these works in California, and 1 in Nevada, classed under springs, draw water from abandoned mining tunnels.

† Two of these supplied from canals.

TABLE 13 F-G-H.

OWNERSHIP OF FAR WESTERN WATER WORKS, WITH POPULATION SUPPLIED BY PUBLIC WORKS, ETC.

Table 13-F. NORTHWESTERN.	Iowa.	Minn.	Kan.	Neb.	Dak.	Wyo.	Mont.	Total N. W.
City or town	33	11	29	32	19	2	2	128
Local company	19	8	34	7	5	3	5	81
Outside company	1	1	5	3	1	.....	.....	11
Individuals	.....	.....	4	1	1	.....	.....	6
Unknown	.....	.....	.....	.....	.....	.....	.....	.....
Total Number	53	20	72	43	26	5	7	226
Population supplied by public works	69,651	115,967	35,488	33,163	11,695	4,907	1,180	271,961
P. C. of pop'n supp'd by city works	26.5	78.5	27.3	36.9	49.2	56.5	11.5	40.5
Pop'n on private w'ks	192,745	31,899	94,428	56,687	12,038	3,788	8,487	400,072
Pop'n per private w'k.	38,549	3,544	2,190	5,153	1,720	1,263	1,697	4,080
P. C. of census city pop'n supplied by public works	34.5	89.6	42.4	62.9	.....	.....	.....	58.1

Table 13-G. SOUTHWESTERN.	Mo.	Ark.	Tex.	Col.	N. M.	Total S. W.	Total N. W., S. W., Pac.
City or town	3	1	20	22	1	47	194
Local company	24	9	27	18	6	84	258
Outside company	.....	.....	1	.....	.....	1	12
Individuals	.....	.....	3	.....	.....	3	25
Unknown	.....	.....	.....	1	.....	1	1
Total Number	27	10	51	41	7	136	490
Population supplied by public works	352,927	1,233	50,613	30,798	1,272	437,023	778,164
P. C. of pop'n supplied by city works	66.0	3.9	30.4	33.7	6.3	51.8	37.9
Pop'n on private works	181,969	30,191	115,794	59,210	19,284	406,448	1,273,381
Pop'n per private work	7,580	3,355	3,730	3,120	3,214	4,561	4,280
P. C. of census city pop'n supplied by public w'ks	69.7	9.4	43.9	52.0	19.2	62.4	48.9

Table 13-H. PACIFIC.	Wash.	Ore.	Cal.	Ariz.	Nev.	Utah.	Idaho.	Total Pacific.
City or town	2	7	6	1	.....	3	.....	19
Local company	6	9	62	2	9	1	4	93
Outside company	.....	.....	.....	.....	.....	.....	.....	.....
Individuals	.....	1	12	1	2	.....	.....	16
Unknown	.....	.....	.....	.....	.....	.....	.....	.....
Total Number	8	17	80	4	11	4	4	128
Population supplied by public works	350	20,631	34,136	1,836	.....	12,227	.....	69,180
P. C. of pop'n supp'd by city works	6.3	53.2	7 8	18.7	.....	88.8	.....	12·9
Pop'n on private w'ks	10,045	14,133	402,472	7,980	30,689	1,542	.....	466,861
Pop'n per private w'k.	1,674	1,413	5,435	2,650	2,790	1,542	.....	4,280
P. C. of census city pop'n supplied by public works	.....	11.7	9 9	26.2	.....	45.7	.....	16.5

TABLE 14—F-G-H.

FAR WESTERN WATER-WORKS REPORTING OVER 100 METERS IN USE.

NORTHWEST GROUP.	
Des Moines, Ia.	1,000
21 others	421
(31 without meters)	1,421
Minneapolis, Minn.	228
St. Paul, "	249
7 others	101
(11 without meters)	578
Leavenworth, Kan.	310
24 others	203
(47 without meters)	513
Omaha, Neb.	400
5 others	68
(37 without meters)	468
Fargo, Dak.	160
5 others	307
(20 without meters)	467
SUMMARY. Wks.	Met.
Over 100 m 6	2347
Under 100 m 62	1100
No meters 158	....
226	3447

SOUTHWEST GROUP.	
St. Louis, Mo.	2,143
Kansas City, Mo	950
15 others	147
(10 without meters)	3,240
Ark., 5 small works	88
El Paso, Tex.	400
Gainesville, Tex	103
15 others	408
(34 without meters)	911
Trinidad, Col	125
8 others	49
(32 without meters)	174
N. Mex., 3 miles	12
SUMMARY. Wks.	Met.
Over 100 met 5	3721
Under 100 met. 46	704
No meters 86	....
136	4425

PACIFIC GROUP.	
Wash., 3 works	37
Oregon, 3 works	54
San Francisco, Cal	8,500
Los Angeles, Cal.	150
Oakland, Cal.	150
San Diego, Cal.	245
Alameda, Cal.	550
17 others	189
(58 without meters)	9,784
Ariz., 2 works	58
Nev., 1 work	20
SUMMARY. Wks.	Met.
Over 100 met. 5	9595
Under 100 met. 20	350
No meters 103	....
128	9945

WORKS HAVING OVER ONE-SIXTH OF THEIR TAPS METERED.

Towns	p. c. metered
Des Moines, Ia.	40.0
Moorhead, Minn.	22.7
Red Wing, "	22.1
Leavenworth, Kan.	27.4
Owego, Kan	60.0
Fargo, Dak.	38.7
Pierre, Dak.	22.5
Maryville, Mo	22.5
Hot Springs, Ark	20.0
Newport, Ark.	28.3
El Paso, Tex.	50.0
Gainesville Tex	25.8
Leadville, Col	27 8
Calvert, Tex.	25.0
San Francisco, Cal.	32.7
Menlo Park, Cal.	25.2
San Diego, Cal.	17.5
Alameda, Cal.	55.0
Prescott, Ariz.	17.6

TABLE 7—F-G-H.

NORTHWESTERN, SOUTHWESTERN AND PACIFIC STATES.—CLASSIFICATION OF WATER-WORKS BY SIZE OF TOWN IN 1880.

STATES.	1,000 or under.	1,000 to 3,000.	3,000 to 5,000.	5,000 to 10,000.	10,000 to 20,000.	20,000 or over.	Total No.
Iowa	10	19	10	7	4	3	53
Minnesota	4	7	1	5	1	2	20
Kansas	29	32	5	2	3	.....	71
Nebraska	25	14	2	.....	1	1	43
Dakota	19	5	2	.....	.....	.....	26
Wyoming	2	2	1	.....	.....	.....	5
Montana	5	.....	2	.....	.....	.....	7
Total N. W.	94	79	23	14	9	6	225
Missouri	1	7	8	6	1	3	26
Arkansas	2	3	4	.....	1	.....	10
Texas	18	16	7	4	3	2	50
Colorado	25	10	4	.....	1	1	41
New Mexico	1	4	2	.....	.....	.....	7
Total S. W	47	40	25	10	6	6	134
Washington	4	2	2	.....	.....	.....	8
Oregon	9	7	.....	.....	1	.....	17
California	27	33	7	3	2	3	75
Arizonia	2	1	.....	1	.....	.....	4
Nevada	6	2	2	.....	1	.....	11
Utah	.....	1	1	1	.....	1	4
Idaho	4	.....	.....	.....	.....	.....	4
Total Pac	52	46	12	5	4	4	123
Tot'l Far West'n	193	165	60	29	19	16	482
Total Eastern	143	395	225	215	106	83	1,167
Total U. S.	336	560	285	244	125	99	1,649

TABLE 9-F-G-H.

NORTHWESTERN, SOUTHWESTERN AND PACIFIC STATES WATER-WORKS.—KIND OF WORKS.

STATE.	Gravity.	Pumping to				Unkno'n	Total.	P. C. gravity works.
		Reservoir.	Tank.	Stand-Pipe.	Direct.			
Iowa	2	13	16	5	16	1	53	3.8
Minnesota	3	5	2	4	8	.....	22	13.6
Kansas	.....	13	18	30	9	.....	70	.....
Nebraska	.....	9	7	19	6	1	42	.....
Dakota	10	4	5	2	4	1	26	38.4
Wyoming	2	.....	1	.....	1	.....	4	50.0
Montana	1	2	1	.....	3	.....	7	14.3
Total No. W'n	18	46	50	60	47	3	224	8.0
Missouri	.....	9	4	9	6	.....	28	.....
Arkansas	1	3	3	2	3	.....	12	8.3
Texas	.....	8	13	29	5	.....	55	.....
Colorado	24	4	5	1	7	1	42	57.1
New Mexico	4	3	.....	.....	.....	.....	7	57.1
Total So. W'n.	29	27	25	41	21	1	144	20.1
Washington	3	3	2	.....	1	.....	9	33.3
Oregon	6	5	2	1	3	1	18	33.3
California	47	22	14	3	5	1	92	51.0
Arizona	2	1	1	1	.....	.....	5	40.0
Nevada	10	1	.....	.....	.....	.....	11	91.0
Utah	4	.....	.....	.....	.....	.....	4	100.0
Idaho	3	.....	1	.....	.....	.....	4	75.0
Total Pacific	75	32	20	5	9	2	143	52.5
Total Far W'n	122	105	95	106	77	6	511	23.8
Total Eastern	338	247	119	181	217	19	1,121	30.1
Total U. S.	460	352	214	287	294	25	1,632	28.2

TABLE 16—F-G-H.

FAR WESTERN WATER-WORKS.—PUMPING CAPACITY IN MILLIONS OF GALLONS PER DAY.

Makes of Pumps arranged alphabetically.	Northwestern Group.					Southwestern Group.				Pa'f'c	
	Iowa.	Minn.	Kans.	Neb., etc.	Total N. W.	Mo.	Ark. & Tex.	Col. & N. M.	Total S. W.	Total Pacific	Total Far West.
Blake	9.6	7.3	5.8	7.8	30.5	9.8	14.1	2.0	5.5	3.0	59.4
Buffalo	.....	.....	7.6	3.0	10.6	.....	5.5	.....	.....	.....	16.1
Cameron	0.1	.....	.....	.....	0.1	.....	.....	1.0	1.0	1.0	2.1
Deane	2.2	3.0	21.1	10.0	36.3	12.0	4.3	0.8	17.1	.....	53.4
Dow	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.4	8.4
Gordon & Maxwell	12.6	.....	5.0	2.5	20.1	.....	3.8	2.0	5.8	.....	25.9
Holly-Gaskill	26.8	1.0	23.3	27.5	78.6	32.3	18.5	9.3	60.1	12.8	151.5
Hooker	.....	.....	.....	.....	.....	.....	.....	.....	16.0	8.7	8.7
Knowles	15.1	1.5	0.8	18.8	36.2	1.5	10.3	4.2	13.2	5.3	57.5
Smith & Vaile	0.3	....	5.5	1.8	7 6	3.4	9.8	.....	2.0	.....	20.8
Walker	.....	.....	.....	.....	.....	2.0	.....	.....	.....	.....	2.0
Worthington	13.3	17.2	15.5	9.3	55.3	38.9	41.8	2.8	82.9	32.3	170.5
Miscellaneous	13.0	80.8	7.0	32.7	133.5	21.5	7.2	8.1	136.8	21.8	292.1
	93.0	110.8	91.6	113.4	408.8	220.8	115.3	30.2	366.3	93.3	858.4

Table 8 shows the cost per head supplied on water-works to be very high in the far West, a fact in part due, undoubtedly, to more rapid growth of population since the census, but only in part: for there is no doubt that the western investments are proportionately greater than in the East. The cost per mile of main is more trustworthy and likewise more uniform. In the Northwest it averages $15,660, in the Southwest $21,580 (largely because of the enormous cost of the St. Louis water-works, $13,000,000 or $41,220 per mile of main this one work aggregating 40.3 per cent. of the total Southwest investment), in the Pacific group $19,800, and in the whole far West $19,150, against $17,500 in the eastern United States.

The cost per tap also ranges high in the far West, being $406 in the Northwest, $359 in the Southwest, and $438 in the Pacific group, averaging $401, against $184 in the rest of the United States. The revenue per tap varies but little from the average of $37.30 in either group (being $40.70 on the Pacific coast), but is very high in comparison with the eastern United States, which averages only $16.60. The revenue per mile of main, however, is singularly uniform throughout the country, being $1,778 in the three far Western groups, against $1,583 in the rest of the country, indicating that the higher revenue per tap is a necessity because of fewer taps per mile of main.

The per cent. of revenue (gross) to cost is very remarkably uniform in the three far West groups at 9.30 per cent. against 9.66 per cent. in the rest of the United States. Considering the great difference in abundance and cost of capital for such uses, the far West shows great enterprise in building works for so small return.

Table 9, showing the kind of works, needs no special comment, unless to draw attention to the large proportion of gravity works on the Pacific coast (larger even than in New England, and much larger than in the Middle States) and to the small number of direct pumping works as compared with those pumping to stand-pipes and tanks. It is natural that there should be a large proportion of works pumping to reservoir; because the topography favors reservoirs, but the disfavor shown to direct pumping is notable, as will more fully appear in our summary of the works of the whole United States.

Table 10, of sources of supply, shows a great excess of wells in the Northwestern group, and a very heavy proportion of wells in the Southwestern and Pacific group,—as large as in the South and much larger than in the Northeasterly group. Lake and brook supplies are extremely few throughout the far West, for a very good reason. Lakes and brooks are rare in the far West, even in mountainous and northerly regions. In the Southwest 69 per cent. of the works are supplied from rivers and wells, and 75.1 per cent. of the Northwestern works are so supplied.

The usual Tables 11 and 12, showing working and fire pressures, are omitted from this series, the number of works in each State being so few that it did not appear necessary to summarize each separately. The aggregate for each of the three groups will be shown in Tables 11-S and 12-S, giving summaries for the whole United States.

Table 14 shows in detail the practice of the several States as respects meters. As a whole, considering the newness of the works, meters are in quite general use in the far West. San Francisco is the second city in the country as respects use of meters.

The usual table of hydrant rental (Table 15) is omitted, it not appearing necessary to summarize the States and Territories of the far West separately. The aggregates for each of the three groups are shown in Table 15-S, to follow, in the summary for the whole United States.

Table 16 shows the total of pumping capacity, in part by States and in part (when the States or Territories had but few works in each) by groups of States. The contrasts, as in former groups, are in some cases notable and curious; as for instance, that there should be nearly three times as many Holly pumps as Worthington in Nebraska, Dakota, and Wyoming, while there are over twice as many Worthingtons as Hollys in Arkansas and Texas. The reasons for these differences, however, and the moral to be drawn from them, we leave every one interested to study out for himself. As in other groups, the total of "Miscellaneous" is very large, consisting chiefly of a comparatively small number of very heavy special pumps at the larger works.

The New Territory of Oklahoma.

In view of the attention which the settlement of this Territory is now attracting, and the important and speedy results which are likely to flow therefrom, the following abstract of the main facts of the situation will probably be of interest.

The Oklahoma region, which is opened on Monday next (April 22) to settlement, consists of 1,887,100 acres (11,694 homesteads of 160 acres each, or 82 townships of 36 sq. miles) near the very center of Indian Territory, and separated by a belt of nearly 60 miles (the "Cherokee Outlet" strip) from Kansas. The entire area of Indian Territory is 64,092 sq. miles to which might be added 5,738 sq. miles in "No Man's Land," which, however, is not a part of Indian Territory and is already occupied by about 9,000 whites, who are wholly without legal organization as a part of the body politic. The area now opened to settlement, consequently, consists of only 4.6 per cent. of the total area of Indian Territory.

The "Cherokee Outlet" strip, which will undoubtedly be opened to settlement soon—as Commissioners to that end have been authorized by Congress, appointed, and are now on the ground negotiating for its purchase from the Cherokees, so far as they have any right to it—is a much larger tract in the extreme northwest of the Territory, about 10 townships (60 miles) wide, north and south, and 26 townships long, and contains 6,022,000 acres or 9,409 sq. miles, sufficient to give 37,637 homesteads of 160 acres, or in both tracts 49,432 homesteads. Assuming an average family of 5 on each homestead (which gives a population of 20 per sq. mile, the average of the whole United States being now about 22½) this gives room for a population of 247,160, to which is to be added the estimated 9,000 who are already in "No Man's Land." The claim therefore seems in every way reasonable that in a time, certainly not exceeding two years, there will be a new and full-fledged State of Oklahoma knocking for admission and fully entitled to it, with a population of at least 150,000 and an area of 12,358 miles, taken from Indian Territory (19¼ per cent. of it) and 5,738 miles of "No Man's Land," or 18,096 sq. miles in all, which is about half the area of Ohio (40,760 sq. miles) and more than twice that of Massachusetts (8,040 sq. miles.) This of course is apart from any further purchases which may be made from the Indians, to increase the available territory.

This still leaves over 4-5 of the Territory, or 206,936 homesteads of 160 acres each, in the possession of the Indians. At 5 per homestead, or 20 per sq. mile, there is room on this remaining land for a population of 1,034,680. Were it populated as densely as Arkansas and Mississippi were at the last census (24.5 per sq. mile), there would be room for 1,267,000; or if as densely as Tennessee and Kentucky (nearly 40 per sq. mile), there would be room for over 2,000,000. The actual number of Indians occupying this area has never been exactly determined. The census of 1880 is silent about it, but in 1879 the official estimates were 78,142, and the number is probably little if any greater now. This number belonged to some 30 different tribes and cultivated after a fashion 263,000 acres or about 411 sq. miles of land, being 0.64 of 1 per cent. of the total area of the Territory, and 0.79 of 1 per cent. of the total area which will remain after both Oklahoma and the "Cherokee Outlet" strip have been opened for settlement.

Were every man, woman and child among the Indians given 160 acres each, it would take only 30½ per cent. of its area, and still leave 69½ per cent. which might be given up to settlement, or about three times as much as it is now proposed to open up. Were each Indian family (assuming them to average 5 each) given 160 acres of land, and the remainder sold and the price invested for their benefit, only 6 per cent. of the total area of Indian Territory would be required to so provide for the Indians in it, leaving some 2,500 acres per Indian family to be sold for their benefit.

Would not such a disposal of these lands benefit the Indians more than to hold for so-called hunting purposes a vast area which they do not use? Do equity and justice to the Indians require that they should play dog in the manger indefinitely with so vast an area, keeping 2,000,000 from homes for which they are willing to pay a fair price to enable 80,000 Indians to perpetuate the hollow mockery of a savage hunting life? It appears to us clearly not; but in any case it is becoming every day more certain that the pressure to open these lands to settlement will be practically irresistible, whether it ought in equity to be yielded to or not. It appears to us clear, also, that a true regard for the welfare of the Indians alone would lead to putting a speedy and summary stop to the farce of a tribal organization; would give each Indian his land in severalty, would make it inalienable for a long term of years or one or two generations, would invest the price of land sold as a permanent fund for their benefit; would provide machinery for the ultimate admission of Indians to the full rights and duties of citizens, and would then leave the Indians, after a suitable period of pupilage, to either conform to the habits and customs of civilization or gradually die out, as their aptitudes and inclinations tend. This would be in the end the best and fairest for the Indians themselves, and likewise so much better for the whites that it is quite certain to be the actual course of events.

It is alleged that much of the land now opened to settlement is not really very good, but there can be no doubt that as a whole the land is the best remaining for original settlement in the United States.

That the development of Indian Territory by the Indians is not advancing very rapidly is indicated by the areas under cultivation. The acres cultivated were in

1879	1880	1881	1882	1883	1884
263,000	314,398	346,000	370,000	400,000	320,000

We have not at hand any later statistics relating to Indian Territory only, but there has been no great change since this date. In 1888 there were estimated to be 243,299 Indians in the entire United States, apart from Alaska, of which 58,590 wore citizen's dress and 25,255 could speak English well enough for ordinary conversation. In 1884 there were estimated to be in Indian Territory *only* 64,000 who wore citizen's dress, and 45,000 who spoke English as stated. In 1880 the total number of Indians was estimated at 303,248, with 103,969 more in British America.

The 64,000, more or less, civilized Indians in Indian Territory are divided up among five different tribes, each of which has a "constitution," modelled on that of the United States, legislative, executive, and judicial bodies, treaties with the United States, etc., etc. To them therefore it can be no hardship to change their status to that of citizens of the United States, instead of remaining a nation within a nation. It is not generally known that the way in which the title to Oklahoma became vested in the United States, was by forfeiture resulting from the "late unpleasantness," in which the Indians espoused the cause of the seceders.

PUBLICATIONS RECEIVED.

—*Graphics; or the Art of Calculation by Drawing Lines.* —Applied especially to Mechanical Engineering. With an atlas of diagrams. By ROBERT H. SMITH, Professor of Engineering, Mason College, Birmingham, etc., etc. Part I. Price $5.00. Longmans, Green & Co., Publishers, London and New York, 1889.

This work, which will be more fully reviewed hereafter, is intended to enable readers having a knowledge of elementary mechanics to apply that knowledge to everyday problems without the aid of complicated alge-

braic, trigonometrical formulæ or of calculus. It deals with the graphic method, and introduces Graph-Arithmetic and treats algebra and trigonometry in a similar manner. The bulk of the work is devoted to the application of graphics to the statics of engineering structures.

—*Department of Public Safety*, Pittsburg, Pa. Code of Laws, Ordinances and Regulations governing the Building Inspectors, Inspector of Plumbing, Gas-Fitting and House-Drainage and Board on Wooden Buildings, 1889.

The chief merit of this publication, and it is an important one, is its handy form, all of these laws, etc., being condensed into a thin volume of 72 pages 3½ x 5½ ins. size. It is a good example for other cities to follow.

PERSONAL.

Mr. D. W. FLANNIGAN has been appointed Street Commissioner at Waverly, Minn.

Mr. WILLIAM CALLERY, President of the Pittsburg & Western Ry. Co., died at Pittsburg, Pa., April 5.

Mr. EDMUND B. WESTON, Assistant City Engineer of Providence, R. I., has been elected an Associate Member of the Institution of Civil Engineers, of London.

Mr. A. J. MCDOWELL, of Boston, auditor of the Mexican Central Railway Co., died at Albuquerque, N. M., recently.

Mr. L. F. BASSETT, for 11 years City Engineer and Surveyor of Sacramento, Cal., having relinquished that position, has started in business for himself.

Mr. C. A. CARPENTER, of Rochester, N. Y., has been appointed Superintendent of construction of the Lincoln Park & Charlotte Ry.

Mr. FRED. J. H. RICKON has been elected City Engineer of Little Rock, Ark. He has held this position before.

Mr. E. C. WINSTANLEY has been appointed General Manager of the Zanesville & Ohio River Ry. The office of Traffic Manager on that line has been abolished.

Mr. J. R. ALLEN has been appointed Superintendent of the Seattle, Lake Shore & Eastern Railway, with office at Spokane Falls, Wash. Ty.

Mr. S. T. MCNAIR has been elected Auditor and Treasurer of the Interstate Commerce Railway Association. Mr. MCNAIR is Chief Clerk in the office of the Comptroller of the New York, Lake Erie & Western.

Mr. HENRY CUSTER, formerly of Washington, D. C., and known as a civil engineer in connection with the government surveys, died recently at his home in Rheineck, Switzerland.

Hon. JAMES P. MAXWELL, of Boulder, Col., has been appointed State Engineer of Colorado, vice J. SIRE GREENE, whose term has expired. Capt. JOHN S. TITCOMB is the Deputy State Engineer, that office having been created by the Legislature recently adjourned.

Mr. GEO. V. MORFORD, formerly a prominent railway man, died recently at Kankakee, Ill. His brother, JOHN B. MORFORD, is Division Superintendent of the Canadian division of the Michigan Central.

Mr. J. B. PORTER, the newly appointed Engineer of Maintenance of Way on the Cincinnati, Hamilton & Dayton, has made an inspection trip over the road. Mr. H. PIERCE, whom he succeeded, has gone to the Chesapeake & Ohio road.

Mr. H. A. FISHER has resigned the position of Treasurer of the St. Louis, Alton & Springfield road in order to devote all his time to his duties as General Manager. Mr. L. C. HAYNES, of St. Louis, has succeeded him as Treasurer. Mr. HAYNES is also the Secretary of the company, and his headquarters will be at Springfield, instead of St. Louis.

GEN. JAS. S. NEGLEY has returned from a trip to London, Eng., on business connected with the Mexican Pacific Coast R. R. This road is intended to run from San Diego, Cal., to Moglattan, from there to Guadalajara, connecting with the Mexican Central to City of Mexico. This road has valuable concessions from the Mexican Government. It is now said to have fair prospects.

Mr. J. D. FINN, Superintendent of the Yellowstone division of the Northern Pacific, has been appointed Superintendent of the Montana division in place of Mr. W. MCC. WHITE, resigned; headquarters, Livingston, Mont. Mr. F. H. MARSH, Chief Train Dispatcher of the Yellowstone division, has been appointed Superintendent of that division, succeeding Mr. FINN; headquarters, Glendive, Mont.

Mr. JOHN B. KERR, having resigned as Acting General Manager of the New York, Ontario & Western Railway Co., will resume his duties as general counsel of the company, and Mr. JOHN BURTON will be General Manager. Mr. R. D. RICKARD has been elected Secretary and Treasurer in place of Mr. BURTON. Mr. CHARLES A. DRAPER has been appointed Purchasing Agent and Paymaster in place of Mr. RICKARD.

Mr. CHARLES A. TROWBRIDGE, a pioneer among mining and railroad engineers, died at his residence in New York City, on April 13, aged 72 years. Mr. TROWBRIDGE became interested at an early date in the copper mines of Michigan, and was one of the men who proposed and pushed to completion the Sault Ste. Marie canal. He is said to have been a member of the first party of civil engineers that crossed the plains in prospecting for a transcontinental railway. He was a brother of Prof. WM. A. TROWBRIDGE, of Columbia College.

GEN. CHARLES KINNAIRD GRAHAM died at Lakewood, N. J., April 15. He was born in New York in 1824, and in 1841 became a midshipman in the U. S. Navy, serving in the Gulf during the Mexican war, after which he resigned from the service. Returning to his native city, he devoted himself to the study of civil engineering. In 1857 he was appointed constructing engineer of the Brooklyn Navy Yard, the dry docks and landings being built under his supervision. In 1861, when the civil war broke out, he joined the Union Army. He was Chief Engineer of the Dock Department from 1873 till 1875, and Surveyor of the Port of New York from 1878 to 1883.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—At the regular meeting on April 17, it was announced that the time of the Convention had been changed from the end of May to the middle of June.

A paper on "The Mississippi as a Silt-Bearing River," by WILLIAM STARLING, M. Am. Soc. C. E., Chief Engineer of the Mississippi Levee Commission, was read by the Secretary. Referring to the different methods proposed for the improvement of the river, it was stated that reservoirs would have to be on too large a scale to be practicable, besides being enormously expensive, while the proposed new mouth, 100 miles or so from the present mouth, would have no effect 100 or 200 miles above it. The levees are about 3 ft. above the highest known water level, but new ones are built with the top about 5 ft. above the high water of 1888; they are generally 8 ft. wide on top, with slopes of 1:3 on each side, except in special cases. Capt. EADS' theory was that the water could only carry a certain amount of silt and that when charged with that amount it would not cause further damage to the banks; he therefore favored contraction works above the shoals so as to cause the water to gorge itself with silt. Major POWELL, on the other hand, thought the damage done was in proportion to the amount of silt carried, and favored reservoir systems. In point of fact, however, while there is an average amount of silt which the water carries in suspension, it will carry a greater amount at times, as when banks cave in, and will gradually deposit it along the river. The jetties at the mouth of the river are very successful. It has been said that the river is subject to no laws, but Mr. STARLING thought that it was governed by laws the same as other rivers.

Mr. COLLINGWOOD referred to the wanderings of the Chemung river in New York State. Mr. WOODBURY referred to some jetties in the upper Potomac, which were built by GEORGE WASHINGTON about 1760, and which are still in good condition; they are walls of heavy stone, reaching only up to low-water mark so as not to interfere with ice, logs, etc., during the winter floods.

Mr. STRIEDINGER described a system of longitudinal training-walls for river improvement, invented by Mr. WOLF, and tried on the river Iser in Bavaria. A row of piles is driven and a floating mattress secured to them, the mattress being in the inshore side of the piles; this checks the current in the bend of the river and silt is deposited; when this takes place, the mattresses are gradually loaded with stone near the row of piles, so that they assume an inclined position and eventually become the covering of the foreshore. Mr. WORTHEN thought such a large river as the Mississippi required a treatment of its own, and that large and continuous appropriations should be made for the carrying out of the improvement works.

Mr. HERMAN SCHUSSLER, the engineer of the San Mateo dam of the San Francisco water supply, described the construction of this work. The dam is of concrete blocks made in place and interlocking. The work has been described in ENGINEERING NEWS, March 2, 1889.

Engineers' Club of Cincinnati.—A regular meeting was held March 28, with 21 members present. Messrs. A. I. TOLTEN, WM. ARCHER, E. W. WULFEKOETTER and JOHN G. D. MACK were elected members.

In the absence of any regular paper, Mr. R. L. READ gave an interesting description of the new freight depot and storage warehouse recently constructed under his supervision by the C. I. St. L. & C. By. Co., at Cincinnati, to replace the old and inadequate sheds which have served for many years. The new buildings are quite attractive and commodious, affording a large amount of storage room for flour and other goods and convenient and well adapted accommodations for the handling of the large freight business done by the road.

Mr. ANDERSON described a bridge which had been designed to carry a sewer drain across a ravine at the new military post being established at Newport, Ky. The bridge, which is a masonry arch of 60 ft. span and having a rise of 6 ft., presents some original features of construction which were discussed by those present.

The Denver Society of Civil Engineers of Denver, Col., has become the Denver Society of Engineers and Architects and now numbers some 60 members.

American Water-Works Association.—The convention at Louisville, Ky., opened April 16. The opening session was devoted to the regular order of business. At the afternoon session three papers were read: "Water-Works Records," by J. M. DIVEN; "Flushing Street Mains," by H. W. AYRES, and "Increased Revenue from Private Sources," by C. N. PRIDDY. A great deal of interest was manifested by local men.

New England Railroad Club.—At the meeting on April 10, a paper was read by ANGUS SINCLAIR on Compound Locomotives. The paper with the discussion will be found in another column. The subjects for discussion at the next meeting will be "The Rules of Interchange of Freight Cars," and "The Desirability of Increasing the Size of Car Axles."

The Western Railway Club.—At the meeting on April 16, the subjects for discussion were: "Axles for 60,000 lbs. Cars" (continued discussion and "Interchange Rules."

WALTER D. CROSMAN, *Secretary.*

Master Car Builders' Association.—Mr. M. N. FORNEY has tendered his resignation of the office of Secretary, which he has held almost from the beginning of the organization of the Association, in the following letter dated New York, March 14, 1889:

To the Members of the Executive Committee of the Master Car Builders' Association.

GENTLEMEN: As other interests demand all of my time and attention, I have decided that I will not accept a reappointment as Secretary of the Master Car Builders' Association, should it be tendered to me after the next Annual Convention. As the business of last year has all been completed, and little or none of that for the current year has yet been begun, it seems to be desirable if a new incumbent of the office is appointed, that he should assume its duties before, rather than after, the Convention, so that he will become familiar with the business which will be transacted during the meeting, which must be embodied in the annual report for the current year.

For these reasons I hereby request the Executive Committee to relieve me of the office and duties of Secretary of the Association at as early a date as it may be possible to agree upon my successor.

In relinquishing my official relations to the Association I feel sure that it will be a pleasure to me hereafter to remember the acquaintances and friendships which have been made during the time that I have occupied the position of Secretary and to recall the period and the experience of my term of office. Trusting that the pleasant personal relations of the past will be continued and that the prosperity and usefulness of the Association may increase in the future, as it has in the years that are left behind us, I am,

Yours very respectfully

M. N. FORNEY.

The resignation has this time been accepted by the Executive Committee, no doubt with much regret. Mr. FORNEY has several times before tendered his resignation, but never before in so peremptory a form as this.

Rensselaer Society of Engineers.—At the special meeting held April 5, at Troy, N. Y., Mr. AUG. S. KIBBE, Assistant Engineer on the New York State canals, read a paper entitled "Some Detail of Canal Work." He traced the history of canals in this State from their commencement down to the present time, and then described the practice of the present day as compared with the theory. The paper ended by giving statistics concerning the length and public use of the State canals. The paper was illustrated by drawings showing sections and plans of locks, etc.

Association of North American Railroad Superintendents.—At the meeting of the association in New York last week, officers were elected, reports of committees presented and matters briefly discussed. The Committee on Machinery presented a report on steam heating systems now in use for railway cars. Only three papers on railway track having been received in competition for the prize of $50 offered by the Committee on Roadway, the time for receiving papers was extended to May 1. The president read a paper on the maintenance of discipline on railways. A committee was appointed to consider the establishment of permanent offices in New York. A communication on "Improvements in Railway Track," which had been prepared by Mr. E. E. RUSSELL TRATMAN at the invitation of the Secretary, was presented, and after being read was referred to the Committee on Roadway. The paper noted the introduction of heavy rails and heavy joint fastenings, and suggested that more attention should be paid to securing a more efficient fastening of the rails to the ties than the spike now generally used. It further suggested that the roadway or other committees should be directed to consider the adoption of standard rail sections and joint fastenings; also the questions of improved fastenings to the ties, metal ties, frogless or safety switches, etc. The paper was illustrated by blue-

prints of heavy rail sections, and a drawing showing the adaptation of the Sandberg screw fastening and the English fang-bolt fastening to an 80 lb. American rail

[An abstract of this paper will be given next week.]

The following officers were elected:—President, C. S. GADSDEN, Charleston & Savannah Ry.; Vice Presidents: L. W. PALMER, New York & New England, J. B. MONFORD, Michigan Central, and WATERMAN STONE, Interstate Rapid Transit Ry. (Kansas City); Secretary, C. A. HAMMOND, Boston, Revere Beach & Lynn; Treasurer, R. M. SULLY, Richmond & Petersburg. The office of the Secretary is at 345 Atlantic Ave., Boston, Mass.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Stewiacke Valley & Lansdowne.—For the following information regarding this Nova Scotia Railway we are indebted to Mr. LIONEL H. BUCK, of Upper Stewiacke, Nova Scotia, the Company's engineer;

Donald Grant, of New Glasgow, N. S., has the contract for 25 miles on this road, from Graham's Siding on the Intercolonial Ry. to Crockett's. Surveys are now in progress from Crockett's to Lansdowne Station on the Pictou Branch Ry., 11¾ miles, and a branch is proposed to run from Lansdowne to Westville, 13½ miles. Grading will be started during the present month.

Maine Central.—Grading has begun on the Dexter & Piscataquis extension. A new station will probably be built at Dexter.

Gettysburg & Harrisburg.—Chief Engineer A. E. LEHMAN, of Carlisle, Pa., has begun surveys for an extension from the present terminus to near Gettysburg, Pa. It is said that the line may be extended to Washington, D. C.

Chicago & Grand Trunk.—The annual report of this company shows the following results of operation:

	1888.	1887.
Gross earnings.....	$3,228,338	$3,478,696
Operating expenses	2,412,446	2,524,890
Net earnings.....	815,892	953,806

Wheeling & Lake Erie.—The directors have declared the regular quarterly dividend of 1 per cent.——The report that an extension from Toledo to Detroit is to be undertaken this season is emphatically denied by the company's officers.

Cooperstown & Charlotte Valley.—The extension of this New York road is now nearly ready for the rails.

Lehigh Valley.—The locating surveys are completed for an extension of the Harvey's Lake branch, about 20 miles, to a connection with the Loyalsock R. R. and the Berenice coal fields.

Pennsylvania, Poughkeepsie & Boston.—The Campbell Hall Connecting Ry. Co. has been chartered in New York, in this company's interest, to operate a railway from the New Jersey State line to Campbell Hall, 18 miles. The road is already constructed from the State line to Pine Island, and from here a branch of the Erie system runs to Campbell Hall. This will probably be purchased or leased to form part of the new route.—— The contract for an iron bridge over the Delaware river at Portland, Pa., has been let to the Edge Moor Iron Co., of Wilmington, Del. The piers and abutments were built by the Pennsylvania, Slatington & New England company some years ago. The new structure is to be completed by June 1.

New York, Lake Erie & Western.—Some years ago surveys were made for a railway from Rush Junction, few miles south of Rochester, N. Y., via Honeoye Falls and Lima to Hemlock lake, about 15 miles. The project is again under discussion, but it is not likely that any work will be done this season.

Rochester & Glen Haven.—The 1¼ mile extension, from Glen Haven to Irondequoit Bay, will be completed by May 10. WM. C. GRAY is Chief Engineer.

Wilkesbarre & Western.—It is stated that a syndicate, composed of FRANK C. HOLLINS and other prominent capitalists, has made arrangements to complete a new line of railway from the coal fields of central and eastern Pennsylvania to New York City. The scheme includes the construction of a line of railway to be known as the Bellefonte & Eastern, from Bellefonte to Newberry, near Williamsport, Pa., about 50 miles. From this point a line will be built to Turbotville on the Wilkesbarre & Western, which is to be extended east to Shickshinny on the Susquehanna river. The final link will be furnished by the construction of an extension of the New York, Susquehanna & Western, from Stroudsburg west to Shickshinny.

Canadian Pacific.—It is announced that the Government has arranged with the company that in consideration of the privileges granted them by the bill now before the Dominion Parliament, the construction of the 115 mile link between Harvey and Salisbury, N. B., shall be pushed at once. The estimated cost is $2,000,000.——The Flint & Pere Marquette R. R. is to be one of the most important of the Michigan connections of the system. Trains will be run from Chatham to Sarnia over the Erie & Huron Ry.

Grand Trunk.—It is expected that the chief railway subsidy granted by the Dominion Government at this session of Parliament will go to this company in aid of the Port Huron tunnel enterprise. About 15 per cent. of the cost will go the probable amount of the subsidy.

Mt. McGregor.—This company has been organized in New York to succeed the Saratoga, Mt. McGregor & Lake George Co. W. J. ARKELL, of Canajoharie, is President.

Cleveland & Canton.—Grading for the entrance of the Coshocton & Southern Ry. to the city of Zanesville, O., is now in progress.

Niagara Central.—A party of surveyors has begun work at Hamilton on the proposed Toronto extension of this Canada road.

Philadelphia & Reading.—The company will soon finish laying the Bound Brook division with 90 lbs. rails. About 45 miles were laid last year. The extension to Cape May, N. J., is still under consideration.

McKeesport & Belle Vernon.—The contractors expect to complete this Pennsylvania road to Carrollton by July 1.

Moose River.—Grading for this road in Herkimer county, N. Y., was completed last fall. It is to run from Moose river to Jones' Camp, 7 miles, and will be used for lumber and tourist traffic.

Michigan Central.—Surveys are in progress for a new route between Niles and Buchanan, Mich., which will avoid the numerous curves and steep grades on the present line.

Concord.—A subscription is being raised to purchase right of way for the extension from Burnstead Center to Gilmanton Iron Works.

Potts.—Grading is in progress on this road, which is being extended from Oscoda to the northern part of Montmorency county in the forests of northern Michigan.

Projects and Surveys.

Phillips & Rangely.—The incorporators of this Maine company met at Farmington April 17, and elected HENRY P. CLOSSON, of Gardiner, President: and FREMONT E. TIMBERLAKE, of Phillips, Clerk and Treasurer. It was voted to make preliminary surveys at once. The line will be narrow gauge and will tap valuable timber tracts.

Georgetown & Tenleytown.—This company is securing right of way for its proposed road near Washington, D. C. Gen. DRUM is President.

Richfield Springs.—Five different projects for a railroad to this popular resort in Central New York are now being agitated. They are the Bethlehem, Schoharie & Richfield Springs R. R.; the Saratoga & Richfield Springs R. R.; the Richfield Springs & Cooperstown R. R.; the Oneonta & Richfield Springs R. R.; and the Wharton Valley & Richfield Springs R. R.

Peru & Detroit.—This company, whose incorporation was noted in our issue of April 6, has commenced the survey of its proposed line.

Washington & Western Maryland.—G. T. DUNLOP, L. V. BAUGHMAN, SPENCER MATTHEWS, J. B. HENDERSON and others of Washington, D. C., have incorporated railway company by this name.

Westerly & Jewett City.—A project is on foot to build a line of railway from Westerly, R. I., to Jewett City, Ct., a distance of about 18 miles. MILLEN S. GREENE and ALVA C. LOWREY, both of Westerly, are interested.

Keeseville, Ausable Chasm & Lake Champlain.—This company has been incorporated in New York to build a railway from Keeseville to Port Kent, a distance of 6 miles. Among the incorporators are: GEO. N. KINGSLAND, CONANT S. TAYLOR and RICHARD HOAG, of Keeseville, N. Y.; WM. M. MOONEY, of Ausable Chasm, and LEWIS S. CRANDALL, of Troy, N. Y.

Plymouth & Sandwich.—JAMES M. HODGE, of Plymouth, Mass., writes us that he is engaged on the preliminary survey for a railway to run from Plymouth to Middleboro, a distance of 15 miles.

Marion & Indianapolis.—This old project to build a railway from Marion, Ind., via Elwood and Noblesville to Indianapolis, about 65 miles, is again being agitated.

SOUTHERN.—Existing Roads.

Chesapeake, Ohio & Southwestern.—The contract for a 5-mile extension of the Elizabethtown & Hodgenville railway has been let to Thomas H. Hays, of Louisville.

Georgia Southern & Florida.—About 600 hands are at work on the extension from Valdosta, Ga., to Lake City, Fla., 60 miles, and it is expected to complete it by July 4.

Georgia, Carolina & Northern.—A lease has been executed by this company to the Seaboard & Roanoke R. R. Co.——It is stated that the work on the extension toward Atlanta is soon to be resumed.

Atlantic & Danville.—Rails are on the ground and tracklaying is in progress on the western division of this road from Danville, Va., east.

Orange Belt.—The formal opening of this Florida road took place on April 12 at Sanford. The line now extends from St. Petersburg, on Tampa bay, to Sanford, 154 miles.

Owensboro, Falls of Rough & Green River.—Grading has been completed by Contractor C. H. Dishman from Owensboro to Whitesville, Daviess county Ky., and tracklaying is to begin in a few days.

Danville & New River.—The City Council of Danville, Va., has made a proposition to the bondholders for the reorganization of this company. They propose that the road shall be changed to standard gauge and shall enter Danville over an independent track.

Alabama Midland.—All but $5,000 of the $90,000 subscription asked of Tuscaloosa, Ala., in aid of the extension of the road to that point has been subscribed.—— All the grading between Troy and Bainbridge will be finished by May 1, and the contractors will then begin work on the line between Troy and the terminus of the Northwest & Florida railroad. The track-laying gangs are making good progress.

Richmond, Fredericksburg & Potomac.—The contract for grading part of the belt line connecting with the Richmond & Petersburg near Richmond has been sublet to W. G. Gibbons.

Norfolk & Western.—The annual report of this company shows the following results:

	1888.	Increase.
Gross earnings	$4,899,598	$644,804
Expenses and taxes.....	3,001,927	518,146
Net earnings.....	$1,897,671	$126,657

The company has added to its rolling stock during the year 24 engines, 11 passenger coaches, 1,478 freight cars and 63 cabooses. The increase in the mineral traffic amounted to 542,866 tons, and in the coal and coke traffic to 462,197 tons.

President KIMBALL says:

Surveys have also been made for the further development of the iron ore territory between your Crippie Creek extension and the Cape Fear & Yadkin Valley Railroad. The distance between the present termini of the two lines is about 45 miles, and that portion of the connecting link to be built by your company, 35 miles in length, will develop the resources of a section of country containing iron, zinc, and copper ores, and furnish considerable local traffic. Your management considers the proposed connection an important one, and that it should be undertaken in the near future.

Knoxville Southern.—A. A. ARTHUR, Manager of the American Association, Limited, of Knoxville, Tenn., writes that the whole line from Knoxville, Tenn., south to the Georgia State line is now under construction by contractors Thos. McFarland, S. P. Condon, Wm. D. Burgin, T. W. Keeler & Co., and others. A 600-ft. bridge is to be built at Knoxville across the Tennessee river, but is not yet under contract.

Knoxville, Cumberland Gap & Louisville.—Track has been laid from Knoxville north nearly to the Clinch river, a distance of about 30 miles.

Marietta & North Georgia.—At the annual meeting held at Marietta, Ga., April 9, FRANCIS KENDALL, of Boston, was elected Vice-President and J. B. GLOVER, Treasurer.

Clarksburg, Weston & Midland.—The stockholders of the Clarksburg, Weston & Glenville and the Clarksburg & West Fork R. R. companies met at Weston, W. Va., April 10, and voted to consolidate under the above name and to change the road to standard gauge between Clarksburg and Weston. The roads are to be operated in connection with the Monongahela River Railroad, soon to be put under construction, in which Senator J. N. CAMDEN, of Parkersburg, is interested.

Eutawville.—At the annual meeting of this South Carolina company it was stated that 35 miles of the road from Pregnalls to Harlin City are now in operation. Ten miles have been graded north of the Santee river and the bridge over that stream is finished except the trestle approach. All the rails and ties for the extension are on the ground and tracklaying will begin soon.

Richmond & Danville.—The Northwestern North Carolina road has been opened for business from Winston to Rural Hall, on the Cape Fear & Yadkin Valley Railway, 13 miles. Grading is in progress on a farther extension to Wilkesboro.——A disputed right of way has caused considerable trouble between employés of this company and the Durham & Northern at Durham, N. C.

Covington & Macon.—A meeting was held at Griffin, Ga., on April 12 to discuss the proposed extension of this system to that point. Cash subscriptions in aid of the work were made to the amount of $20,000. W. E. H. SEARCY headed the list with a subscription of $2,500.

Louisville & Nashville.—It is reported that a branch is to be built from Greenville to Marianna, Fla., and also one from Ebernant (near Bessemer, Ala.,) to the Dudley mines, about 4 miles.——J. W. Worthington & Co., contractors for the Red Gap extension of the Birmingham Mineral R. R., have sublet to Reed, Fortenberry & Co., 2 miles; Carpenter Bros., 1 mile; M. McTighe & Co., 2 miles; Sims Bros., 2 miles; and Adams & Minge, 1¼ miles.

Cincinnati, Alabama, & Atlantic.—Chief Engineer O. H. P. CORNELL has established his headquarters at Tullahoma, Tenn., and will continue work on the surveys.

Suffolk & Carolina.—A correspondent sends us the following:

At the annual meeting of this company held at Suffolk, Va., April 11, Messrs. J. S. GITTINGS, DOUGLASS THOMAS, S. P. RYLAND, J. HOUGH COTTMAN, W. C. SEDDEN and WM. H. ROSLEY were elected directors.

The board elected CHAS. F. PITT, Jr., President; CHAS. H. JONES, Jr., Vice-President and General Manager; W. B. OLIVER, Treasurer; JOHN S. GITTINGS, Secretary.

The P. O. address and headquarters of the company are at Suffolk, Va. The report of the President to the stockholders shows a large increase for the year 1888 over 1887; and the company has begun the year 1889 with a business that promises to exceed that done in 1888.

Richmond & Allegheny. — This road was sold at Richmond, Va., April 16, by order of the Court, and was bid off by Chas. F. Cox, of New York and others, representing the bondholders, at $5,000,000.

Chesapeake, Ohio & Southwestern.—Work is to begin very soon on a union depot at Louisville, which will cost about $150,000.

Cincinnati, Selma & Mobile. — The company has been refused trackage for its trains over the East Tennessee, Virginia & Georgia railroad between Selma and Marion Jc., Ala., and will be obliged to either effect a lease of the Selma & New Orleans track between Selma and Elizabeth, or build an independent line between these points.

Birmingham & Atlantic Air Line. — Col. W. E. H. SEARCY, of Griffin, Ga., President of this company, sends us the following information concerning this enterprise:

The route for this road has been surveyed from Birmingham, Ala., to Macon, Ga., and rights of way have been secured for half the distance. The line is to run via Talladega, Ashland, Roanoke, Ala., Lagrange, Greenville, Culloden, and Thomaston, Ga. Forty miles are now graded and additional work is to be let at once. Tracklaying is expected to begin by May 1, and a part of the line will be opened for business within 100 days. The company was chartered in 1886. H. S. WATT is Chief Engineer and H. S. MORSE General Manager.

Projects and Surveys.

Meridian Belt.—A company has been organized at Meridian, Miss., to build a belt line railway around the city. The road will be standard gauge and laid with 56-lb. steel rails. Among the incorporators are C. W. ROBINSON, JOHN W. FEWELL, J. M. RICHARDSON, and C. A. LYERLY, all of Meridian. J. M. T. HAMILTON, of Meridian, is Chief Engineer.

Ocean View.—This company, organized to build a short road near Wilmington, N. C., has elected STACY VAN PAMRINGE, President; and S. H. MANNING, Secretary and Treasurer. The headquarters of the company will be at Wilmington, N. C.

Macon & Birmingham.—We have received the following information from F. S. JOHNSON, of Macon, Ga., President:

The surveys for this road, which is to run from Macon, Ga., via La Grange, Ga., to Birmingham, Ala., a distance of 210 miles, will commence April 15. We intend to build a first-class road, with heavy steel rails, masonry culverts and iron bridges. No local aid is asked except right of way, which will be granted. The contract for construction will be let in May or June. The company was incorporated February, 1889. W. H. WELLS, of Macon, Ga., is Chief Engineer.

Indian River & Lake Poinsett.—Incorporated in Florida to build a tram-road from Lake Poinsett to Rock Ledge and Cocoa. Among the incorporators are C. B. MAGRUDER and H. S. WILLIAMS, of Tallahassee, Fla.

Anderson & Tennessee River. It is stated that H. M. ALGER and others, of Anderson, Tenn., will build a narrow-gauge railway from Anderson to the Tennessee river, a distance of about 12 miles.

Athens & Jefferson.—It is stated that this company will commence work on its proposed road about June 1. The road is projected to run from Athens, Ga., to Jefferson, Ga., a distance of 18½ miles. DAVID C. BROWN, Jr., of Athens, is Chief Engineer.

Central Valley.—A press report states that the locating surveys for this line, which is projected to run from a point on the Ohio river, opposite Madison, Ind., south through Kentucky to the Tennessee State line, a distance of about 150 miles, will commence soon. A. T. KEIGHTLEY, of Greencastle, Ind., is President.

West Virginia & Pennsylvania.—This company, whose incorporation was noted in our issue of March 16, has completed the preliminary surveys for its proposed line, and it is stated that construction will commence soon.

Rutledge & Julian.—Surveys have been made for this road, which is projected to run from Rutledge, Ala., to Julian Station, on the Northwest & Florida R. R., about 3 miles.

Black Diamond. — Surveys are reported in progress for the Virginia, Parkersburg & Ohio R. R., which is projected to run from Parkersburg, W. Va., to Clifton Forge, Va., a distance of 250 miles.

Lexington Belt. — This company has been organized with LESLIE COMBS, President, JOHN R. ALLEN, Vice-President, and R. R. STOLL, Secretary, to build a belt line transfer around the city of Lexington, Ky.

Norcross, Warsaw & Cumming.—Col. HENRY COLLIER, of Atlanta, Ga., Chief Engineer, has completed the survey for this road, which is to run from Norcross, Ga., to Cumming, Ga., a distance of 21.15 miles. A favorable route was secured with a maximum grade of 80 ft. per mile and a maximum curve of 6°. The cost is estimated at $32,647.

Bowling Green & Northern.—G. SAWYER, of Bowling Green, Ky., Chief Engineer, has completed the preliminary survey for this road, which is to run from Bowling Green to Litchfield, about 40 miles. It is stated that a line will also be built from Bowling Green to Scottsville, a distance of 25 miles.

Dallas & Altoona. — It is reported that JOHN P. RICHARDSON, and others, of Dallas, Miss., will build a narrow-gauge railway from Dallas to Altoona, a distance of about 35 miles.

Wilmington, Onslow & East Carolina.— The locating surveys are in progress on this road, which is to run from Wilmington, N. C., to Jacksonville, N. C., a distance of 48 miles, and construction will commence as soon as a sufficient length of the line has been located. ROBERT LAMB, of New York, is Chief Engineer.

Monongahela River.—The contract to build this road from Fairmont to Clarksburg, 35 miles, has been let to the Parkersburg Improvement & Construction Co., of Parkersburg, W. Va. It is stated that they will sublet the work. Work will probably commence about May 1.

Florence Belt. — It is stated that the Lauderdale Manufacturing Co., of Florence, Ala., is building a belt railway around the city. It is expected to have it completed by May 10.

THE NORTHWEST.—Existing Roads.

Indianapolis, Decatur & Western.—The final survey for the extension from Decatur to Beardstown has just been completed. It is expected that grading will begin May 1. The line will cross the Illinois Central at Cornland, and the Chicago & Alton between Elkhart and Williamsville.

Chicago, Milwaukee & St. Paul.—The annual report of this company shows the following results for the year 1888: gross earnings for year, $24,867,730; operating expenses and taxes, $17,377,353; net earnings, $7,490,377; income from other sources, $218,173; net revenue for the year, $7,708,551; total revenue and surplus account, $11,783,549; interest, $7,084,976; old accounts charged off, $234,126; dividends, 6 per cent. on preferred and 2½ on common stock, $2,270,733; making total payments, $9,553,835; balance income account, $2,229,714.

The statement of the bonded debt shows that at the end of the year it was $118,984,000, or $250,000 less than a year ago.

The rate per ton per mile was 1.006 cts. against 1.09 the previous year. In 1879 the company received 1.72 cts., and in 1869, 3.10 cts. per ton per mile.

The freight carried was 201,586 tons more than a year ago, but on account of decreased rates the earnings from freight traffic were $744,023 less than in the preceding year. The balance sheet shows that at the close of the year the company had a net floating debt of $4,399,521.

Duluth, Red Wing & Southern. — Tracklaying on this line was completed from Red Wing to Zumbrota, Minn., on April 9. The bridge across the Zumbro river, at Zumbrota is not yet completed, and the road will not be opened for traffic until this is done.

Danville, Chicago & Northwestern.—The survey for this line, which is to be a connecting link between the Wabash and the Cairo, Vincennes & Chicago roads, has just been completed.

Belleville, Centralia & Eastern. — Surveyors for this Illinois line, which is to be a part of the Mackey system, are working from Centralia east via Rome.

Duluth & Winnipeg.—The fight over this company's disputed land-grant is still exercising the Minnesota Legislature. There seems little likelihood that any action for or against the company will be taken at this session.

St. Paul, Minneapolis & Manitoba.—A special committee has been appointed by the Minnesota Legislature to investigate the charge that this company has engaged in wholesale stock watering.

Chicago, Burlington & Quincy.—The cutting down of expenses is going on all over the system. Vice-President H. B. STONE says that the railroad business is dull and that the company intends to avoid all possible expense and run their business on the most economical basis consistent with the maintenance of a high standard.

Chicago & Northwestern.—A report has been published that the proposed transcontinental line to be formed by a western extension of the Fremont, Elkhorn & Missouri Valley Ry. across Wyoming is to be pushed through this season. The story seems on its face to be quite improbable.

Projects and Surveys.

Missouri River, North Platte & Denver.—Incorporated in Nebraska to build a railway from a point on the Missouri river in Burt county west through Nebraska and Colorado to Denver, an estimated distance of 500 miles. Among the incorporators are A. M. ROBBINS, WM. F. CODY, PETER MORTENSON, and S. S. HADLEY. F. M. SACKETT, of Albion, is also interested.

Dakota.—The Watertown, Aberdeen & Northwestern, and the Watertown, Sioux Falls & Chicago railway companies have been organized by the citizens of Watertown, Dak.

Chicago, Hannibal & Springfield.—Incorporated in Illinois by ROLAND C. NICKERSON, JOSEPH LATHROP, GEO. B. LATHROP, and others of Chicago, Ill., to build a railway from Chicago to a point on the Mississippi river opposite Hannibal, Mo., with a branch to Quincy, Ill., a distance of about 260 miles. This is the continuation of the Chicago, Hannibal & Springfield R. R., of Missouri, projected to run from Springfield, Mo., to Hannibal, Mo., a distance of 235 miles.

Creston & Southeastern.—The route now decided on for this Iowa road is from Omaha and Council Bluffs via Cass and Adams counties, and thence to Stahl, Mo., on the Quincy, Omaha & Kansas City road, a total distance of about 175 miles. A. P. STEPHENS, of Creston, is interested. A preliminary survey is to be made at once.

THE SOUTHWEST.—Existing Roads.

Cape Girardeau & Southwestern.—On April 15 through trains began running between Cape Girardeau and Kansas City over this road and the Current River branch of the Kansas City, Fort Scott & Memphis system. The extension has been just completed from Wappapello west to Hunter on the Current River R. R., making the main line of the Cape Girardeau road 94 miles in length.

Louisville, New Orleans & Texas. — This company has purchased the Clinton & Port Hudson R. R. in Louisiana and will extend the line to Bayou Sara to connect with the road to Woodville, Miss., recently purchased. ——Right of way is being secured for the ferry transfer and terminal tracks at Helena, Ark.

Kansas City, Wyandotte & Northwestern. — This company has purchased the Lawrence & Emporia Ry. in Kansas, and may build from Lawrence to Tonganoxie, 14 miles, to connect with it.

Missouri, Kansas & Texas. — President R. V. MARTINSEN has returned from a European trip and states that he has secured capital to extend the system to Kansas City and St. Louis independent of the Missouri Pacific lines. A plan for reorganization has been proposed by which the stockholders are assessed 10 per cent. and the bond interest is scaled down to 4 per cent., the bondholders receiving preferred stock to make up for their loss of interest.

San Antonio & Aransas Pass.—The subscription of $150,000 in aid of the extension to Brownsville, Tex., is nearly raised.

Dallas, Pacific & Southeastern.—On this Texas road grading has made good progress on the first division from Dallas northwest 15 miles, and locating surveys are about finished for 60 miles farther. The contractors for the first 100 miles are Burkitt & Murphy, of Palestine, and Burns & Peters, of Dallas. J. E. HENDERSON, of Dallas, is President.

Queen & Crescent.—A large amount of new steel is to be laid on the Vicksburg & Meridian and the Vicksburg, Shreveport & Pacific Railroads and the line will be thoroughly ballasted.

Pojects and Surveys.

Reed Springs & Kansas City.—The directors of this company, whose incorporation was noted in our issue of March 6, are: E. J. REED, of Kansas City, Mo.; J. D. SWAN, of Reed Springs; SAMUEL HARDWICKE, of Liberty; M. N. EWING, GEO. P. SWAN, J. A. HAYES, and M. C. NIXON, of Kansas City, Mo.

Pueblo, Oklahoma & New Orleans.—A company by this name is being formed by Pueblo, Colo., capitalists to build a railway from Pueblo through Oklahoma to New Orleans.

Houston Belt & Magnolia Park.—This company has been incorporated by J. T. BRADY, W. D. CLEVELAND, C. A. MILBY and others of Houston, Tex.

New Orleans Public Terminal & Transfer.—A charter has been drawn up to incorporate a company by this name, having power to construct and maintain surface and elevated roads and bridges, and all that is necessary to the operation of a complete ocean, river and railway terminal system within and covering the approaches to the city of New Orleans. W. G. T. CARVER, J. E. AUVRAY, E. H. CHADWICK and others of New Orleans are interested.

Kansas City, Texarkana & Shreveport.—It is reported that a Mr. FORSTMAN has let contracts and begun grading for a railroad from Texarkana, Ark., north to the Red river and has sent engineers out to locate the line north toward Ft. Smith.

Arkansas.—The *Arkansas Gazette* says:

The following is the list of new railroads projected in the State, the completion—as the case may be, or the construction of which, is assured by reason of their backers, and the resources of the territory penetrated.

Eleven lines are in part completed and in operation, as follows: Fort Smith & Little Rock extension of the 'Frisco, Fort Smith & Gurdon extension of the St. Louis, Iron Mountain & Southern, Fayetteville & Little Rock extension of the 'Frisco, Clarendon & Little Rock extension of the Midland R. R., Pacific & Great Eastern, from Fayetteville to White river; Texarkana & Northern, Texarkana & Shreveport, White & Black River R. R. from Brinkley to Newport; Brinkley & Helena R. R., Arkadelphia, Ultima Thule & Mississippi River R. R., Southwestern Arkansas & Indian Territory R. R.

In the case of five others, construction has been undertaken in adjoining States, on the roads, together with completing their locating surveys within its bounds, heading for Arkansas. The following are the roads so conditioned. Fort Scott, Natchez & New Orleans R. R., Houston, Louisiana & Central Arkansas R. R., Springfield & Little Rock extension of the 'Frisco to Chadwick, Mo., Kansas City, Fort Scott & Gulf extension toward Fort Smith, and the St. Louis & Little Rock extension of the 'Frisco to Salem, Mo.

The remaining five out of the twenty-one have not only completed their locating surveys in the State, but have filed profiles of their line, and secured right of way, depot grounds, and donations of land. They are as follows: Kansas City, Arkansas & New Orleans R. R., Little Rock, Hot Springs & Indian Territory R. R., Memphis, Arkansas & Kansas R. R., Fort Smith & Dardanelle R. R., and the Little Rock & Alexandria R. R.

ROCKY MT. AND PAC.—Existing Roads.

Oakland, Alameda & Laundry Farm.—This company is reported to have let contracts, for building one mile of road and excavating about 300 ft. of tunnel, to A. C. RUMBLE, of Oakland, Cal.

Oregon Pacific.—According to press reports this company has secured a new supply of funds, and will resume work on grading its eastern extension soon. Chief Engineer ECKELSON has already started the locating survey.

Spokane Falls & Northern.—Grading is in progress on this Washington Territory road. One mile has already been completed, and tracklaying will commence as soon as the rails arrive.

Seattle, Lake Shore & Eastern.—The Seattle & Eastern Construction Co. has increased its capital stock $2,000,000. Of this $1,000,000 is offered to stockholders up to April 25, and will be used in the construction of the northern branch of the Seattle, Lake Shore & Eastern R. R.

Northern Pacific.— This company has built an extension this year from Laurel Junction, Mont., on the main line, up Rocky Fork river, and through the Crow Indian Reservation to Red Lodge, a distance of 43.9 miles.——It is announced that the route for the Butte branch to Butte has been determined upon, and the line through the Homestake pass chosen. The branch is to be built and ready for operation by Nov. 15, 1890.

Port Townsend Southern.—The contract for building the first 6 miles of this road has been let to Payne Bros., of Port Townsend, W. Ter. Work has already commenced. The contract for grading the next section of 19 miles will be let within 30 days. J. B. HOGG, Port Townsend, W. T., is President.

Oregon & Washington Territory.—Good progress is being made on the surveys for the line from Walla Walla, W. Ter., to the Grand Ronde Valley. The engineers are now at work on the line through the mountains about 35 miles south of Colfax.

Oregon Railway & Navigation Co.— Engineers are now at work locating the extension of the line from Rockford, W. T., to Spokane Falls. Work on construction will commence immediately.

Tacoma & Fern Hill.—A press report states that this road, running south from Tacoma, W. T., has been opened for traffic.

Pasadena.—It is announced that this road, which was completed last year from Raymond, Cal., to Altadena, a distance of 7½ miles, will be extended to Los Angeles and the base of Mount Wilson, from which point it will continue to the top of the mountain, on a plan similar to the railway running to the top of Mt. Washington, N. H. A. B. MANAHAN, of Pasadena, Cal., is General Manager.

Projects an Surveys.

Samish, Skagit Valley & Spokane.—Incorporated in Washington Territory to build a line of railway from Samish to Spokane Falls, a distance of about 250 miles. Among the incorporators are C. G. AUSTIN, S. L. BOWMAN and E. M. JOHNSON, of Samish, W. T.

Los Angeles & Hueneme.—This road will run from Los Angeles through the San Fernando and Santa Clara Valleys to a point near the town of Hueneme, Ventura county, with a branch from some point on the main line to a connection with the Southern Pacific at Saticoy or Montalvo. Among the directors are: JOHN M. C. MARBLE and W. G. HUGHES, of Los Angeles, and THOS. R. BARD and ALFRED J. SALISBURY, of Hueneme, Cal.

Pasco, Goldendale, Vancouver & Portland.—A railway company by this name has been incorporated in Washington Territory, with headquarters at Pasco, W. T.

City & West Portland Park.—Incorporated in Oregon to build a motor line from Portland to West Portland and West Portland Park, and to any other point in Multnomah, Clackamas or Washington counties. The incorporators are E. T. HOWES, F. R. FERRIS, and J. E. BENNETT, of Portland.

Gig Harbor & Port Orchard.—A project is being agitated to build a line of railway from Gig Harbor, near Tacoma, W. T., to Port Orchard, a distance of about 15 miles. GEO. P. EATON, of Tacoma, is interested.

Brighton & Plymouth.—GEO. W. HANCOCK, D. A. LINDLEY and others of Brighton, Cal., are discussing the project of building a railway from Brighton to Plymouth, Cal.

Stockton, Fresno & Southern.—It is reported that construction on this road, which is projected to run from Stockton, Cal., to Visalia, Cal., a distance of about 175 miles, will begin within two weeks. Eighteen thousand tons of steel rails, 8 mogul engines and a large number of box cars have been purchased for the road. FREDERICK HOMER, of Stockton, is interested.

Elk Creek.—Incorporated in California to build a railway from a point near the mouth of Greenwood Creek, Mendocino county, to Elk Creek, with a branch down the right bank of Alder Creek, a total distance of 32 miles. Among the incorporators are: L. E. WHITE, CHAS. E. WILSON, E. J. DODGE, and T. POLLARD.

San Diego & Northeastern.—Incorporated in California to build a railway from San Diego northeast to Escondido. It is said that the new incorporation will probably include the San Diego, Old Town & Pacific Beach R. R., which is projected to run from San Diego via Old Town to Pacific Beach, a distance of 11 miles. Among the directors are: A. G. GASSEN and A. R. THOMAS, of San Diego.

Tacoma, Ellensburg & Conconnully.—It is announced that a syndicate composed of W. R. ADAMS, and JOHN A. SHOUDY, of Ellensburg, W. Ter., and E. P. CALDWELL and J.V. MOFFITT, of Wichita, Kan., will build this road from Ellensburg to Port Eaton, on the Columbia river, 34 miles, on condition that $100,000 subsidy be raised by the citizens of Ellensburg.

Puget Sound & Gray's Harbor.—T. J. MILNER, Chief Engineer, has commenced the survey of this road from Summit station to Montesano, W. Ter. Work will commence immediately and it is expected to have 20 miles of the road in operation by Jan. 1, 1890.

RAPID TRANSIT.

Electric Railways.—***Augusta, Me.***—The directors of the Augusta & Hallowell Electric Ry. Co. are receiving proposals for the equipment of the road, which is to be opened by July.

Biddeford, Me.—The Biddeford & Saco Street Ry. Co. is considering propositions to operate its line by electricity.

Waltham, Mass.—The Newton Street Ry. Co. has been authorized to operate its line through the city by electricity, using overhead wires.

Albany, N. Y.—The Albany Ry. Co. has appointed a committee to investigate the different systems of electric propulsion.

Atlantic City, N. J.—The new electric railway is nearly completed and will be in operation by June. It is owned by the Pennsylvania R. R.

Knoxville, Tenn.—An electric railway is projected. For particulars address Messrs. Luttrell, Temple & Brown.

Spartanburg, S. C.—An electric railway is to be built to Clifton. It will cost about $100,000. For particulars address A. H. LEFTWICH, of Greenboro, N. C.

New Orleans, La.—The Coliseum Street Ry. Co. will experiment with an electric storage battery motor.

Decatur, Ill.—The Citizens' Electric Ry. Co. has been incorporated by W. L. FERGUSON, W. L. SPELLABARGER, and J. L. KINNEY.

Portland, Ore.—The Metropolitan Street Ry. Co. has been granted a franchise for an electric line.

Seattle, Wash. Ty.—The new electric railway has been opened and is now in operation.

Victoria, B. C.—The National Electric Tramway & Lighting Co. has been incorporated.

Elevated Railways.—***Brooklyn, N. Y.***—The Kings County Elevated Railway is putting in the foundations for the extension along Fulton Ave.

Lake, Ill.—The Equitable Transit Co. has applied for a franchise for an elevated railway.

Dummy Lines.—***Alton, Ill.***—Work is in progress on the extension to Upper Alton.

Minneapolis, Minn.—The Lake Harriet Improvement Association, headed by THOMAS LOWRY, proposes to build a dummy line from the union depot to Kenwood and the lakes.

Tacoma, Wash. Ty.—The Fern Hill dummy line was opened April 4.

Street Railways.—***Buffalo, N. Y.***—The City Council is advertising for proposals for a street railway franchise for the First Ward.

Edgewater, N. Y.—The Village Trustees have granted a franchise to the South Beach Ry. Co. for ½ of 1 per cent. of the gross receipts.

Warren, Pa.—A street railway has been granted the right to extend its lines 3 miles.

Waynesboro, Ga.—A street railway company has been organized by W. A. WILKINS, J. H. MACKENZIE and P. L. CORKER. Capital stock, $4,000.

Atlanta, Ga.—All the street railways have been acquired by a syndicate headed by JAMES SWAN, on a payment of $425,000. The syndicate owns the dummy line, but not the new electric line.

Tiffin, O.—The street railway company has increased its capital stock to $50,000. It has purchased 60 tons of rails and 20 cars for extensions.

Murphysboro, Ill.—The Citizens' Street Ry. Co. has been incorporated by T. M. LOGAN, J. M. HUBERT and T. H. PHILLIPS. Capital stock, $25,000.

Argenta, Ark.—The Little Rock & Argenta Street Ry. Co. has been organized by D. J. NICHOLS and others. Capital stock, $20,000.

The Rudd Electric Rapid Transit Co. has been organized at Chicago by J. L. HOLBROOK, HARLAN E. PATTERSON and W. C. HOLBROOK, to build and operate surface, elevated or underground railways. Capital stock, $100,000.

CONTRACTING.

Dredging Prices.—(CORRECTION.)—Major W. R. LIVERMORE, U. S. Engineer Office, Newport, R. I., writes us as follows in regard to the table published on page 254:—"In your issue of March 23 last, you publish a table of the prices of accepted bids for dredging between Feb. 25, 1888, and Feb. 2, 1889, which is incorrect so far as it concerns the bids for work at Hyannis harbor, Wareham harbor and New Bedford harbor, Mass.; Newport harbor, R. I., Pawtucket river and Pawcatuck river, R. I., and Green Jacket shoal, Providence, R. I. The prices given for these works, while they were the lowest offered, were regarded as excessive, and all the bids were rejected, as well as that for dredging in Providence river, which does not appear in the table. The works have been readvertised, and bids will be opened April 23, 1889.

Lock.—The following proposals for the construction of a new masonry lock in the Muskingum river at Taylorsville, O., were opened April 4, by Lieut.-Col. W. E. MERRILL, U. S. Engineer Office, Zanesville, O.

BIDDERS.	Fine Finished Masonry.	Rough Pointed Masonry.	Rock Face Masonry	Dry Masonry	Brick Masonry	Concrete Masonry	Timber and Plank	Rock Excavation	Loose Rock Excavation	Earth Excavation	Filling behind land wall of Lock	Totals.
A. J. Jolly & Sons, Pittsburg, Pa.	$9.50	$9.50	$7.50	$6.00	$6.00	$4.00	$22.00	$1.00	$0.80	$0.80	$0.30	$61,340.62
Hughes Bros., Syracuse, N. Y.	15.00	14.00	6.75	4.00	8.50	5.00	45.00	1.25	0.70	0.48	0.30	68,827.60
Harrold & McDonald, Pittsburg, Pa.	13.50	9.90	7.50	5.25	7.75	5.85	30.00	2.25	1.65	1.55	0.50	72,471.67
C. I. McDonald, Pittsburg, Pa.....	10.75	9.75	7.50	6.00	9.00	7.50	30.00	3.00	2.50	2.00	0.30	75,543.?2
J. Hugill & Co., Akron, Ohio.....	12.00	11.00	9.00	8.00	8.00	5.00	28.00	.98	2.00	1.00	0.40	78,231 53
Hogg & Pettibidjer, Pittsburg, Pa...	14.70	13.00	10.60	3.50	16.00	8.00	50.00	2.50	1.30	1.00	0.50	88,119.75
T. B. Townsend, Zanesville, Ohio.....	14.50	14.00	10.75	8.25	12.25	7.50	30.00	3.00	1.00	0.40	0.50	90,146.32
W. A. Snodgrass, Marietta, Ohio.....	13.50	12.00	10.00	8.25	12.50	10.00	40.00	3.50	2.50	1.00	0.85	93,662.26

Cast-Iron Pipe.—The following proposals for cast-iron water pipe for the water supply of Washington were opened April 10 by Lieut.-Col. JOHN M. WILSON, U. S. Engineer, office of Washington Aqueduct, Washington, D. C. The amounts are as follows: 22,700 ft. of 48-in., 48 ft. of 36-in., 36 ft. of 30-in., 400 ft. of 24-in., and 24 ft. of 20-in.; also 500,000 lbs. of special castings. Gloucester Iron Works, Philadelphia, Pa.: $26.57 per ton for all sizes of pipe, no bid for castings; bid for 48-in. pipe was for 7,600 ft. Camden Iron Works, Philadelphia, Pa.: $27.38 per ton for 48, 36 and 30-in., $28 for 24 and 20-in., $59.90 per ton for castings; the bid included valves. McNeal Pipe & Foundry Co., Burlington, N. J.: $30.24 for pipe, $56 for castings. Reading Foundry Co., Reading, Pa.: $31 for pipe, $56 for castings: bid for 48-in. pipe was for 7,600 ft. Shickle, Harrison & Howard Iron Co., St. Louis, Mo.: $31.34 for pipe, $70 for castings. The thickness of the pipe is specified to be as follows: 48-in., 1.5 in., 36-in., 1.22 in., 30-in., 1.01 in., 24-in., .92 in., 20-in., .82 in.

Water-Works Supplies.—Mr. CHAS. E. BOLLING, Superintendent of Water-Works, Richmond, Va., has awarded contracts as follows for material for the ensuing year: hydrants (Chapman), West & Branch, Richmond, $22.24; valves (Ludlow) Smith & Courtney, Richmond; valves (Eddy), Southern Railway Supply Co., Richmond; tapping cocks, G. & A. Bargamin, Richmond; lead and solder, G. & A. Bargamin, 4 cts. and 12 cts. per lb.; boxes (Bingham & Taylor), 75 cts. per box. The bids for special castings were from the Tredegar Co., Richmond, 12¼ cts. per lb.; Simpkin & Hillyer, Richmond, 2½ cts. The contract for repairing the streets was awarded to John Weinburner; 37½ cts. per sq. yd. for relaying stone paving, $1.00 per sq. yd. for new stone paving, 48 cts. per cu. yd. for furnace cinders.

Stone.—The following proposals for stone for the jetties were opened April 5 by Capt. F. V. ABBOTT, U. S. Engineer Office, Charleston, S. C.: Anson M. Bangs, Fayetteville, N. Y.: 25,000 tons at outer end of North jetty and 50,000 tons at outer portion of South jetty, $2.43 per ton; 50,000 tons in the main ship channel, $2; 5,000 tons at shore and South jetty, $2.50; total, $234,750. Thomas Young, Charleston, S. C.: $2.40, $2, $2.50; total, $232,500. Southern Construction & Quarry Co., Nashville, Tenn.: $2.25 for North jetty, $2.22 for South jetty, $1.97 for channel, $2.55 for shore and South jetty; total, $219,400. Colin McK. Grant and Geo W. Egan, Charleston, S. C.: $2.17 for North and South jetties, $1.91; $2.52; total, $213,550.

Water-Works Supplies.—The following proposals for pipe and hydrants were opened April 8 by J. MILLS

BROWNE, Surgeon-General, U. S. N., Navy Department, Washington, D. C.: J. J. Lawler & Co., Norfolk, Va., $2,749; Crook, Homer & Co., Baltimore, Md., $2,987; T. C. Bashlor & Co., Baltimore, Md., $3,016: Wm. Rothwell, Washington, $3,935. The contract was awarded to J. J. Lawler & Co.

The contract for 3,500 ft. of 6-in. cast-iron pipe, and 4 and 6-in. pipe and castings for the current year, has been awarded by H. M. FARNSWORTH, Village Clerk of Brooklyn (219 Superior St., Cleveland, O.), to the Lake Shore Foundry, Cleveland, at $26.75 per ton for 6-in., $27.-25 per ton for 4-in. and 2¾ cts. per lb. for castings.

The following contracts have been let by the Water Commissioners of Windsor, Ont.: Neveux Bros., lead, $3.78 per 100 lbs.; Morton & Christie, packing 8 cts. per lb.; R. Whitelaw, Woodstock, for the boiler, $1,195; A. Gartshore, Hamilton, 16-in., 8-in. and 6-in. iron pipe, $34.50 per ton; 4-in. $35.50 per ton; Kerr Bros., Walkerville, hydrants and valves; Edward Bennett, for laying the 494 ft. of suction pipe out in the river, $1,600.

Breakwater.—The following bids for constructing 3,861 lin. ft. more or less, of breakwater, at Ashland, Wis., were received by Maj. JAMES B. QUINN, U. S. Engineer Office, Duluth, Minn., April 5.

Bidders.	*Bid per ft.*	*Total.*
Hugh Steel, Duluth, Minn	$11.45	$44,208.45
Thomas Dwyer, Duluth, Minn	14.63	56,486.43
Powell & Mitchell, Marquette, Mich.	14.73	56,872.53
Zimmerman & Sang, Duluth, Minn.	15.24	58,841.64
Chas. S. Barker, " "	16.00	61,776.00
Houston & Mitchell, Ludington, Mich	16.20	62,548.20
Henry F. Balch, Minneapolis, Minn.	16.70	64,478.70
Lyman J. Burbank, Ashland, Wis.	16.72	64,555.92
Morrison, Roderick & Co., Duluth, Minn	16.81	64,903.41
Schwartz & Berner, Green Bay, Wis.	16.89	65,212.59
Wolff & Truax, Duluth, Minn	17.25	66,602.25
Sherwood & Sutherland, St. Paul, Minn	17.70	68,339.70
Nelson C. Chapman, Minneapolis, Minn	18.20	70,270.20
McCue & Ennis, Duluth, Minn.	18.67	72,470.87
Dear & Hayes, " "	18.78	72,909.58
Hiero B. Herr & Co., Chicago, Ill	19.90	76,833.90
Truman & Cooper, Manitowoc, Wis.	26.00	100,386.00

Pipe Laying.—The water-works committee of Minneapolis, Minn., has received bids for laying this season's water mains from Welsh & Wetherbee, John Gleason & Son, James W. Ryan, John Fleetham, Fred Youngren and John Simonson. The bids ranged from 19 to 94 cts. per ft., which is for pipe ranging from 6 to 24 ins. The lowest bid for laying 6-in. mains was 19¾ cts. and the highest 25 cts. per ft. The prices are said to be considerably lower than it cost the city to lay the same sizes of pipe last year, when the day system was in vogue.

Sewers.—The following proposals for constructing about 1 mile of sewer have been received by the Sewer Dept., New London, Conn.: W. H. RICHARDS, Engineer: C. B. Cadwell, New Britain, $6,243.85; M. S. Austin, Bridgeport, $6,796.40; Frederic E. Shew, Providence, $7,024.50; P. H. Fitzgerald, Waterford, $7,203.80; Carpenter & Kellner, Waterbury, $8,625.50; A. Brazos & Son, Middletown, $10.140. The contract was awarded to C. B. Cadwell at the following prices: $1.20 and $1 per ft. for 12-in.; 95 cts., $1 and $1.10 for 10-in.; 82, 84½ and 85 cts. for 8-in.; manholes, $3.95 per ft.

Dredging.—The following proposals have been received by Capt. W. T. ROSSELL, U. S. Engineer Office Memphis, Tenn.: Alabama Dredging & Jetty Co., Mobile, Ala., 12 or 10 cts. per long or short ton. J. E. Blakeman, Moline, Ill., 17 and 11 cts. per long or short ton.

City Work.—Contracts for public work have been awarded by City Engineer DONNELLY, of Kansas City, Mo., as follows: For sewer in district 115, to James Pryor, $2,201.05; in district 135, to William Sloan, $6,677.80; in district 122, to J. W. Williams, $13,801.04; for constructing artificial stone sidewalk, Kansas City Gravel & Tile Co; for grading Salsbury Ave. at 16 cts. for embankment, 80 cts. for 21-in. pipe, 60 cts. for 18-in. pipe, $3 per cu. yd. for rip-rap, to A. D. Johnson; grading Virginia Ave. at 15 cts. per yd. for embankment, to P. C. Fielding; Michigan Ave., at 19¼ cts. for embankment, to W. Hickman; 22d St., 5½ cts.; for excavation, 45 cts. for rock excavation, to John A. Newcomb; 18th St. at 18 cts., for embankment, $6 for rubble masonry to P. C. Fielding.

Congressional Library Building.—Contracts have been awarded as follows by Mr. BERNARD G. GREENE, Superintendent, 145 East Capitol St., Washington, D. C.: excavating foundation trenches, Wm. F. Henry, Washington, 35 cts. per cu. yd.; sand, John B. Lord, Washington, $1.25 per cu. yd.; bricks, A. A. Richards & Co., Washington, $7.15 per 1,000; broken stone, Barnes & Atchison, Washington, $2.15 per cu. yd.; lumber, Willett & Libbey, Washington, $813.

Granite.—The Committee on Highways, Holyoke, Mass., has awarded the contract for 9,000 yds. of paving blocks and 8,000 yds. of curbing to G. T. Webb, of Worcester, at $1.65 per yd.

New Croton Aqueduct.—The Aqueduct Commissioners have awarded to Robert Hanna & Co. the contract for connecting the new aqueduct with the Central Park reservoir and for building a gate-house at 135th St. and Convent Ave. The cost of the work is to be $28,306.75.

Paving.—The Street Commissioners, Nantucket, Mass., have awarded a paving contract to McDermott & Tifford, of Falmouth, Mass., at $3,265.

PROPOSALS OPEN.

Bridges.—Two iron bridges over the Buffalo river. GEO. E. MANN, City Engineer, Buffalo, N. Y. April 22.

Street Railway.—C. G. BURKHART, Secretary, Albany Street Ry. Co., Albany, Ore. April 22.

Street Material.—Crossing-stone, brick, sand, Belgian blocks, etc. C. A. GAST, Clerk, Street Committee, Lancaster, Pa. April 22.

Hall.—Erection of mechanical hall at the exposition grounds. JOSEPH STILLBERG, Architect. THE PROPERTY COMMITTEE, Western Pennsylvania Exposition Society, Pittsburg, Pa. April 23.

Bridges.—Masonry and superstructure of 1 wrought-iron, pin-connected truss, and 6 plate-girder highway bridges; also 1 stone arch bridge. CHARLES DAVIS, County Engineer. JOSIAH SPEER, County Controller, Pittsburg, Pa. April 24.

Cement.—About 2,000 bls. CHARLES DAVIS, County Engineer. JOSIAH SPEER, County Controller, Pittsburg, Pa. April 24.

Brick Paving.—Specifications to be obtained of Mr. HOGE, City Engineer. THE CITY COUNCIL, Charleston, W. Va. April 25.

Pier Work.—New dumping board at the foot of E. 38th St., East river. THE DOCKS COMMISSIONERS, Pier A, North river, New York City. April 25.

Pipe.—Cast-iron pipes and specials; 35 tons of 4-in., 750 tons of 6-in., 350 tons of 8-in., 100 tons of 12 in. (A), 200 tons of 12-in. (B), 200 tons of 16-in. (A), 330 tons of 16-in. (B), 180 tons of 20-in. (A), 1,270 tons of 20-in. (B); 25 tons of special castings. THE WATER BOARD, Boston, Mass. April 26.

Street and Sewer.—About 4,500 ft. of 12 to 40 by 60 ins. sewer, with manholes, basins, etc. Also building Exchange St., including a retaining wall; 35,875 cu. yds. excavation; 2,447 cu. yds. rubble masonry. JOHN A. COLEMAN, Commissioner of Public Works, Providence, R. I April 30.

Stone.—About 7,300 cu. yds. of dimension, footing and coping granite, sandstone or limestone, for the water power dam. Major JOHN R. MCGINNESS, U. S. A., Rock Island Arsenal, Ill. May 1.

Street Work.—Stone block paving, etc. PERCIVAL W. ST. GEORGE, City Surveyor, Montreal, Canada. May 1.

City Work.—Plank walks, pipe sewers, brick and cement sewer. THOS. J. LANAHAN, Clerk, Board of Contract, Albany, N. Y. May 6.

Sewer.—Completing Bread St. sewer. J. A. FAIRLEIGH, City Engineer, Chattanooga, Tenn. May 7.

Pipe Laying.—Laying pipe from New Rochelle, N. Y., to connect with pipes on David's Island. GEO. H. COOK, Asst.-Q. M., U. S. A., David's Island, N. Y. May 15.

Masonry.—Brick and stone masonry for basement story of church. D. B. WOODRUFF, Architect, 335 Third St., Macon, Ga. May 15.

MANUFACTURING AND TECHNICAL.

Saylor's American Portland Cement is so well maintaining its good reputation that the manufacturers have been compelled to double their mill capacity and can now produce 200,000 bbls. per year. The claim is made that its quality has been still further improved and it is delivered either in strong paper bags or cotton-duck bags, with a consequent saving in cost over imported cement in barrels.

Pumps.—The growth of business beyond present manufacturing facilities has obliged the Hall Steam Pump Co. to consider the question of larger shops. Plans for a shop 60 x 200 ft. have been prepared, and it will probably be built during the coming summer, at Wilmington, Del., where the present works are located.

Railway Equipment.—The American Car & Equipment Co., of 10 Wall St., New York City, has purchased the entire narrow-gauge equipment of the Coudersport & Port Allegany Ry., and has furnished the standard-gauge equipment to take its place, the gauge of this road having recently been changed. It has also furnished the entire equipment for the Tucson, Globe & Northern Ry., and the passenger equipment for the Monterey & Mexican Gulf Ry. The company has facilities for carrying out large contracts for supplying material to railways, and purchasing from them what they do not want. A number of locomotives and passenger cars are under repair and others completed ready for immediate delivery.

Fencing.—The Washburn & Moen Mfg. Co., of 16 Cliff St., New York City, has the contract for fencing the Hudson Connecting Ry. from Campbell Hall, N. Y., to Poughkeepsie. The fence will be of galvanized steel strips and chestnut posts.

Traction Engine.—Wood, Taber & Morse, of Eaton, N. Y., have brought out an improved traction engine in which all four wheels act as drivers, the forward or steering axle being driven by compensating gearing operated by a countershaft which has a flexible joint to permit of the independent movement of the steering and rigid axles.

Speed Recorders.—The Boyer speed indicator and recorder is to be fitted to a number of locomotives on western roads. It is manufactured by the Boyer Railway Speed Recorder Co., of St. Louis, Mo.

Railway Material.—About 4 miles of 30 lb. steel rails, and 10 logging cars will be wanted by P. Josserand & Co., of Josserand, Tex.

Locomotives.—The Rhode Island Locomotive Works, of Providence, R. I., have sent 2 engines to the Union Pacific.

The Hinkley Locomotive Co., of Boston, Mass., has recently shipped a 35-ton engine to the St. Louis, Alton & Springfield.

The Schenectady Locomotive Works, of Schenectady, N. Y., have delivered 1 six-wheel switching engine to the Cleveland, Columbus, Cincinnati & Indianapolis. The first passenger engine of a large order from the Chicago, Milwaukee & St. Paul has been completed.

The Baltimore & Ohio has contracted with the Finance Co., of Philadelphia, for 71 locomotives.

The C. W. Hurst Co., of West New Brighton, Staten Id., N. Y., has built a locomotive for factory or colliery use. It has a vertical boiler and will burn coal or crude oil for fuel.

Car Notes.—The Barney & Smith Mfg. Co., of Dayton, O., has built 2 sleeping cars for the Canadian Pacific.

The Indianapolis Car Works, of Indianapolis, Ind., have a contract for trucks for 250 cars for the Georgia Pacific.

The Bradley & Osgood Car Works, of Worcester, Mass., are building passenger cars for the Bangor & Piscataquis.

The Ohio Falls Car Co., of Jeffersonville, Ind., has an order for 40 coke cars for the Tennessee Iron, Coal & Coke Co.

The Harlan & Hollingsworth Co., of Wilmington, Del., is building a number of passenger cars for railways in the Argentine Republic.

The Gilbert Car Works, of Troy, N. Y., are building 4 cars for the Rochester & Glen Haven road.

The American Fire-Proof Steel Car Co. has purchased land for its works at Louisville, Ky.

The Lynchburg Land, Improvement & Mfg. Co., of Lynchburg, Va., is interested in the new car works.

The Smith Safety Steel Railway Car Co. has been organized at Chicago, Ill., by WM. S. BREWSTER, C. W. M. SMITH, SAMUEL G. FIELD, and others. Capital stock, $1,500,000.

Railway Appliances are being furnished to a large railway contracting firm in Russia, by Perkins & Mott.

Construction and Building Companies.—The Helena & Fort Benton Construction Co. has been organized at Helena, Mont., by H. BARBOUR, A. T. GANET, and H. N. WALKER.

The Illinois Construction & Supply Co. has been organized at Chicago, Ill., by LUTHER A. MARSHALL, T. J. HODGKINS, and F. H. MARSHALL. Capital stock, $15,000.

The Puget Sound Architectural Concrete Co. has been organized at Seattle, Wash. Ty., by B. W. MURRAY, F. E. BROWN, and C. F. YEATON. Capital stock, $10,000. It will manufacture concrete and artificial stone.

The Wehn Pavement Co. has been incorporated by ROBT. S. SINCLAIR, of Brooklyn, N. Y., GEO. H. WEHN, of Philadelphia, Pa., and A. C. DOBSON, of Orange, N. J. Capital stock, $16,000. It will manufacture asphalt paving, floors, etc.

The Rosetta Gravel Paving & Improvement Co. has been organized at New Orleans, La., by J. M. HART, C. M. SOUA, and J. H. MENGE. Capital stock, $250,000.

The River & Harbor Dredging Co. has been incorporated at Alexandria, Va. President, N. S. KENYON; Vice-President, J. R. FARNUM: Secretary, J. FRAZIER, all of Washington, D. C. Capital stock, $1,000,000.

Wire Tramway.—The Trenton Iron Co., of Trenton, N. J., will build a wire tramway 3 miles long at Aspen, Col., at a cost of $60,000. J. B. WHEELER, of New York, and D. R. C. BROWN, of Aspen, are interested.

Car Heating.—The Gold Car Heating Co. has an order to equip all the cars of the New York elevated railways with its improved coupler and automatic traps.

Bridge Works.—The machine shop of the Louisville Bridge & Iron Co., of Louisville, Ky., was burned April 8, causing a loss of $90,000.

Car Couplers.—The Standard Car Coupling Co. has been organized by H. B. BURDEN and H. C. SHIELDS, of Troy, and SPENCER PARK, of New York. Capital stock, $100,000.

The Thurmond Car Coupling Co. has improved its coupling and will soon have a new design on the market. Office at 802 F St., Washington, D. C.

The Fox coupler and platform, said to be an improvement on the Miller coupling, has been adopted by the Nevada County Narrow-Gauge Ry. Co.

The National Railway Supply Co., of Belleville, Ill., has been incorporated by GEO. H. POOR, B. L. AUSTIN, T. B. WILSON. Capital Stock, $100,000.

Pipe Works.—The Charlotte Iron Works Co., of

Charlotte, N. Y., proposes to establish a pipe plant. The capital stock will be increased about $100,000. President, GEO. B. SMITH; Secretary, A. S. CLARKE.

The Canada Pipe & Foundry Co. has been organized by JOHN CLENDINNING, THOS. TURNBULL, E. W. WILSON, and others, of Montreal.

Dennis Long & Co., of Louisville, Ky., have a contract for 30 miles of 42-in. pipe for a Pittsburg natural gas company.

The Riverside Co., of Wheeling, W. Va., has a contract for 26 miles of steel pipe for a natural gas line at Lafayette, Ind.

The Pacific Clay Mfg. Co., of Los Angeles, Cal., has been incorporated to succeed the Southern California Water & Sewer Pipe Mfg. Co. It will manufacture vitrified pipe, fire brick, etc. President, E. G. DURANT; Superintendent, C. B. HEWITT. Capital stock, 250,000.

BRIDGES AND CANALS.

Manayunk, Pa.—A joint jury for Montgomery and Philadelphia counties has been taking testimony in regard to making the bridge at Manayunk a free bridge.

The bridge is an iron one, 550 ft. long, with two piers it was built in 1885. The Manayunk Bridge Co. was chartered in 1832, and has been in existence from that date. In the year 1869 the bridge was swept away by the heavy floods of that year. A wooden structure was erected the same year, and later on was replaced by the present iron bridge. This bridge is the only communication between Manayunk and Montgomery counties. The want of a free bridge was so apparent to the needs of the citizens of the two counties that in 1879 the first effort was made in that direction. Since that time at intervals the question has been brought forward for the action of the courts.

Canals.—*Columbia, S. C.*—Work is progressing on the excavation and locks. Convict labor is employed by Mr. Harden, the contractor.

St. Johns & Indian River.—The St. Johns & Indian River Canal Co. has been organized to build a canal from the St. Johns river, at or near Lake Harney, to the Indian river near Aurantia, Fla. The distance is about 11 miles and the estimated cost is about $1,000,000. The corporators are: J. E. OSTEEN, JOHN SAULS, JOHN M. PRICE, WM. S. NORWOOD and GEORGE W. DICKSON.

Illinois & Michigan.—The lower house of the Illinois Legislature has passed the bill providing for widening and deepening the Illinois & Michigan canal to the dimensions of a ship canal, from Chicago to its connection with the Illinois river, and the improvement of the latter to a corresponding degree to its connection with the Mississippi river. The city of Chicago is largely interested in the passing of the bill, as it is proposed to use the stream as an outlet for the city sewage, the disposal of which has long been a serious problem to the authorities.

Bridge Notes.—*Portland, Me.*—The County Commissioners will have a new draw built by the Portland Co. for the Martin's Point bridge.

Middletown, Conn.—It is proposed to organize a company with $150,000 capital stock to build a bridge across the Connecticut.

Rochester, N. Y.—The contracts for the bridges of the electric railway to Charlotte have been awarded to B. P. Smith for the substructure, and the Rochester Bridge Works for the superstructure.

Niagara Falls, N. Y.—Work on the new suspension bridge is progressing rapidly.

Newark, N. Y.—Considerable difficulty has been experienced in building the foundations of the piers of the Clay St. bridge over the Passaic. The masonry of the piers is to rest upon a foundation of piles driven into the solid bed of the river. It was supposed that piles 45 ft. long would be sufficient, but after they were driven down 30 ft. without reaching a solid bed, it was found they would not do, and longer ones were necessary.

Portland, Pa.—The Pennsylvania, Poughkeepsie & Boston Ry. Co. has awarded the contract for an iron bridge across the Delaware to the Edge Moor Bridge Co., of Wilmington, Del.

McKeesport, Pa.—The City Council has passed an ordinance giving the Monongahela Bridge Co. authority to build a bridge at the foot of Market St.

Grafton, W. Va.—The contract for a bridge over the Tygert's Valley river has been awarded by the County Court to the Smith Bridge Co., of Toledo, O. The bid was for a steel bridge with 4 spans, 18 ft. roadway, and 5 ft. sidewalk; the price including piers and masonry is $27,985.

Wheeling, W. Va.—Plans for a stone bridge at Main St. have been submitted by J. H. Rosenberg. The cost of the two designs is estimated at $62,000 and $70,000.

Chattanooga, Tenn.—The Hamilton County Court will issue bonds for $200,000 for a free iron bridge across the Tennessee river. Bids for construction will be received until May 1.

Memphis, Tenn.—The contract for the Washington St. bridge has been awarded to Neely, Smith & Co., of Florence, Ala.

Montezuma, Ga.—The contract for the Flint river bridge has been awarded to the Smith Bridge Co., of Toledo, O., for $6,793. The contract for trestle work was awarded to J. H. Powers, of Perry, Ga., for $3,000. The bridge will be 216 ft. long, and the trestle 700 ft. long.

Cairo, Ill.—The masonry for the Illinois Central bridge across the Ohio river has been completed. The contractor was L. M. Loss, of Rochester, N. Y., who has taken the contract for the masonry of the Kansas City, Fort Scott & Memphis bridge at Memphis, Tenn.

ELECTRICAL.

Electric Lighting.—*Rockland, Me.*—A committee has been appointed by the Council to inquire into the cost of establishing and operating an electric light plant.

Buffalo, N. Y.—A large number of new lights are to be put up in different parts of the city.

West Troy, N. Y.—The village has voted an appropriation of $5,000 for electric light, and the Village Trustees have power to make a contract. The Thomson-Houston Electric Co. has made an offer to furnish 2,000 c. p. lights, not less than 50, at $100 a lamp per year, and to enter into a contract for one, three, or five years.

Moorestown, N. J.—A company is to be organized to put in an incandescent light plant for streets and houses. A. W. MOORE, RUFUS HILL, and GEORGE HEATON are interested.

Washington, Pa.—The stockholders of the Washington Electric Light & Power Co. have increased the capital stock $20,000. Another engine of 100 H. P. and a boiler of 110 H. P. and a 750-light machine will be put in. The capacity will then be 1,250 lights.

Bedford, Pa.—An electric light company has been organized by L. B. DOTY, H. D. TATE and J. E. SMITH, and the plant will be in operation in June. Capital stock, $25,000.

Hagerstown, Md.—The new electric light company will probably put in a Schuyler plant. President, Dr. C E. G. MCKEE; Secretary, GEO. W. SMITH.

Alexandria, Va.—The Schuyler Electric Light Co. has made a proposition to furnish a plant for 60 arc lights at street intersections and over 100 incandescent lights for $14,000, payable in 10 years. The present proposal is to discontinue the use of gas upon the streets and thus allow a wider range of gas for private consumers than can now be supplied by the gas works.

South Pittsburg, Tenn.—The Jenney Electric Light Co. is erecting its plant. A. C. GREEN is the manager.

Tarboro, N. C.—A vote will be taken April 22 on the proposition to issue $5,000 in bonds for an electric light plant.

Rocky Mount, N. C.—It is proposed to issue bonds for an electric light plant of 30 arc lights and 500 incandescent lights. For particulars address W. E. FOUNTAIN, Mayor.

Newton, S. C.—It is proposed to issue $10,000 in bonds for an electric light plant. For particulars address L. L. WITHERSPOON, Mayor.

Anderson, S. C.—The mayor has invited proposals for the electric light plant; 1,000 lights capacity.

Yorkville, S. C.—A company with $9,000 capital stock is being organized to put in an electric light plant.

Elberton, Ga.—It is proposed to organize a company to put in an electric light plant.

Fernandina, Fla.—The Fernandina Light & Power Co. has been incorporated by F. W. HOYT, J. H. PRESCOTT and W. B. C. DURYEE.

Anniston, Ala.—A three years' contract has been made with the Thomson-Houston Co. for 18 arc lights of 1,200 c.p.

Washington C. H., O.—The electric light company has contracted for a Thomson-Houston plant.

Rushville, Ind.—The Council has contracted with the Edison Co. for a plant of 140 lights at a cost of $9,450. The plant to be owned and operated by the city.

Sedalia, Mo.—The plant of the Sedalia Electric Light & Power Co. has been purchased by JAMES GREEN and others, of St. Louis.

Pine Bluff, Ark.—The Water & Light Co. has a seven years' contract for lighting, and will put in a Thomson-Houston plant. The machinery is being supplied by the Pond Engineering Co., of St. Louis. The plant will be completed by June.

The Central Thomson-Houston Co., of Cincinnati, O., has been incorporated under the laws of the State of Ohio, with a capital stock of $200,000, for the promotion and development of the Thomson-Houston system of electric lighting. The company is composed of Cincinnati, Chicago and Boston capitalists, and has purchased the entire business of Stuart & Altenburg, the former agents of the Edison Co. The business of the company will be the organization of local companies, the construction of electric light and power plants, with a depot of supplies for the Central States. A. STUART, H. WADSWORTH and G. P. ALTENBURG are interested.

WATER AND MUNICIPAL.

Newark, N. J.—A bill was passed in the Senate April 17, giving the city power to issue water-works bonds not to exceed $6,000,000.

Filtration at Cincinnati, O.—Superintendent MOORE, of the Water-Works, has reported to the Board of Public Affairs that the cost of connecting the Price hill filtration experiment will be $600. The test will cost $11 per day including the waste of water.

Columbus, O.—The report of Superintendent MCALPINE for the year ending March 31 shows that the total amount of water pumped was 2,258,878,483 galls., an increase of 5.57 per cent. over the previous year. There are 90 miles of cast-iron mains and 710 fire hydrants.

Baltimore, Md.—The Consolidated Gas Co. has decided to issue $7,000,000 in bonds, $500,000 of which will be used for building a fuel gas plant.

Springfield, Mass.—The proposed new water main to Ludlow will not be laid this year. The mayor has prepared a bill, which has been adopted by the Aldermen, authorizing the city to issue $450,000 worth of bonds, payable in 40 years, on the basis of a 36-in. main, but passing the entire question of deciding the size of the main, its cost, and, indeed, everything connected with the matter, over to the next City Council. Annexed to the mayor's message were estimates prepared by City Engineer SLOCUM for a 24, a 30, and a 36-in. main respectively. They are as follows: 24-in. main, 11,768,000 lbs. of iron, $147,100; lead, gates, drains, valves, etc., $12,400; total, $159,500; 30-in. main, 16,883,000 lbs. of iron, $211,039; lead, gates, drains, valves, etc., $15,700; total, $226,737; 36-in. main, 22,906,000 lbs. of iron, $287,075; lead, gates, drains, valves, etc., $18,611; total, $305,686. These estimates do not include the cost of labor and freight.

Herkimer, N. Y.—Mr. F. K. BAXTER, City Surveyor, has made a report on the new water-works, which were designed by him in 1887. The supply is taken from 34 two-in. driven wells, put down by Whitehead & Sluyter, of Herkimer, along the bank of West Canada creek, and after passing through a sediment well, 3 ft. diameter 4 ft. deep, is pumped through an 8-in. discharge main to the distribution system, and the surplus passes to a steel tank with a capacity of 530,000 galls. The ordinary pressure is 77 lbs; fire pressure, 125 to 130 lbs. The pumping engine, with a capacity of 600 galls. per minute, was supplied by the Knowles Steam Pump Co., of Boston, Mass.; the 48 H. P. boiler was supplied by the Porter Mfg. Co., of Syracuse, N. Y. The 4, 6 and 8-in. cast-iron pipe was furnished by R. D. Wood & Co., of Philadelphia, Pa.; the pipes are laid 5 ft. below the street surface. The Ludlow hydrants and Van Rensselaer valves are used. The system comprises 7 miles of pipe, 52 hydrants and 50 valves.

Sewerage.—*Central Falls, R. I.*—The contract for a 4-ft. brick sewer has been let to Collins & Ham, of Boston, Mass.

Brooklyn, N. Y.—The work of sewering the 26th Ward will soon be commenced, now that the act providing for that much-needed improvement has become a law. It will cost about $1,000,000 to carry out the work. Plans have been prepared by City Engineer VAN BUREN.

Greenville, N. J.—A citizens' committee has been appointed to have the sewers inspected, as there is some dissatisfaction over the construction.

Reading, Pa.—A bill has been introduced to authorize the taking of a vote, May 18, on the proposition to issue $300,000 in bonds for sewers. The work to be done by Reading contractors and laborers.

Apollo, Pa.—It is proposed to borrow $30,000 for street and sewer work.

Baltimore, Md.—Mayor LATROBE believes that the construction of the new storm-water sewers can be done better by the City Commissioner than by contract.

Parkersburg, W. Va.—Mr. C. P. BASSETT, of Newark, N. J., has made a report on the proposed sewerage system, recommending the separate system.

Chattanooga, Tenn.—The city has voted in favor of the issue of bonds for $500,000 for street work and $200,000 for sewers.

Raleigh, N. C.—A vote will be taken May 6 on the proposition to issue bonds for $75,000 for sewers and $25,000 for streets.

Atlanta, Ga.—W. D. Pamer and W. Pease & Co. have contracts for sewers and paving.

Jacksonville, Fla.—It is proposed to issue bonds for $750,000 for sewers.

Ensley, Ala.—The Ensley Land Co. will put in the Waring system of sewerage. For particulars address THOS. D. RADCLIFFE.

Vicksburg, Miss.—Sewers are projected and correspondence is invited. Address H. J. THOWBRIDGE, City Clerk.

Milwaukee, Wis.—City Engineer BENZENBERG has prepared a report on the sewerage of the city.

Helena, Mont.—The main sewers are nearly completed, and it is proposed to issue bonds for $130,000 for additional sewers. G. N. MILLER is the engineer.

Seattle, Wash. Ty.—On the recommendation of JOHN G. SCURRY, City Engineer, the council has declined to adopt the system proposed by Col. Waring.

Los Angeles, Cal.—Proposals for the construction of about 20 miles of sewers will be invited shortly. For particulars address City Engineer EATON.

Windsor, Ont.—Proposals for new sewer work have been advertised for by the Town Clerk.

Artesian Wells.—*Easton, Pa.*—The well for the court house and jail yields about 75 gallons per minute at a depth of 240 ft., 42 ft. below the level of the Lehigh river. It is mostly through solid rock. The cost was $1,000 and the necessary machinery and tanks will cost about $2,000.

Florence, S. C.—The citizens have petitioned the Council to have an artesian well bored to furnish a water supply.

Rome, Ga.—The Standard Scale Co. will put down a 4-in. well 1,000 ft. deep.

Riverside, Ill.—The Trustees have let the contract for another well to furnish drinking water. It will be 2,000 ft. deep.

Boone, Ia.—The well was down 1,885 ft. at the end of March, and was then in white sand.

Peru, Kan.—The well is now down over 200 ft. and in granite.

Houston, Tex.—Jonathan Harris has the contract for boring a new well for the Jenney Electric Light Co.

Sewage Disposal.—Much work has lately been accomplished at the East Orange (N. J.) sewage disposal works. The sludge is being pressed into cakes daily as fast as it accumulates, and these cakes are compressed so much harder than they were recently that they are easily handled and do not emit any offensive odor. Now there is not the slightest difficulty in disposing of the material. The effluent is likewise much better than formerly, and the changes now under way will make a still greater improvement.—Newark *Advertiser*.

At Round Lake, N. Y., a chemical system of sewage disposal is being put in by Mr. POWERS, the inventor.

Duluth, Minn.—The Duluth Water & Gas Co. made arrangements some months ago to furnish a supply of water to Superior, but the Common Council obtained a permanent injunction restraining the company from carrying out the work, on the ground that an efficient service was not given to Duluth, and that it would be still worse should the company also supply Superior. In consequence of this, the company decided not to build the gas works, and claims that it has suffered considerable loss in disposing of its bonds. The company now wants to build the high service reservoir and new gas works, but in order to do so would have to perform its contract with Superior; it has therefore asked the council for a dissolution of the injunction.

Atlanta, Ga.—The Water Commissioner has made a reduction in the price of water, and the rates now range from 17 cts. per 1,000 galls. for 100,000 galls. per month, to 8 cts. per 1,000 galls. for over 1,500,000 galls. per month. Large consumers may be required to draw their supplies at night. The operation of the works this summer will demonstrate, Superintendent RICHARDS thinks, that the inflow is insufficient to meet the demands, and it will be necessary to draw largely upon the reserve. "We shall be fortunate," he states, "if the water retains a sufficient height in the reservoir to enable us to filter the amount required."

Jersey City, N. J.—At a meeting April 10 between the Finance Commissioners, the Commissioners of Public Works and the representative of the Montclair Water Co., a motion was adopted requesting the Board of Works to reject the proposition of the company to supply water at $40 per million gallons, and requesting Senator EDWARDS to help the passage of the bill giving the citizens the right to vote for or against water contracts and enabling cities to condemn the water-sheds. The company proposes to use the Passaic water-sheds and to supply Jersey City proper from the reservoir at Ramapo, and Jersey City Heights from the high service reservoir at Great Notch. The latter reservoir will furnish the supply for lower New York and Brooklyn if contracts can be made. The company stated that it would probably take charge of Jersey City Water Department, furnish better water, make extensions where necessary, and pay the interest on the water debt, which debt amounts to $4,800,000.

Nashville, Tenn.—The State Legislature at its last session passed an act authorizing the issuance of bonds by municipal corporations having a population of 40,000 inhabitants or upward, according to the federal census of 1880 that have availed themselves of the powers heretofore granted by the Legislature to issue bonds for water-works purposes, and have negotiated three-fourths of the bonds authorized by previous acts of the General Assembly of the State of Tennessee. This act applies to Nashville. An act was also passed to empower water companies in the State to acquire by purchase or otherwise the property and working franchise of other water-works.

Monroe, Pa.—A charter has been granted to the Monroe Light, Heat & Power Co. Calvin Detrick & Co., of 47 Broadway, New York City, are interested.

Kansas Water-Works.—The Kansas Water-Works & Irrigation Co., of London, England, has been advertising the issue of $1,000,000 first mortgage bonds. The company is incorporated under the laws of the State of Kansas, for supplying water to the towns of Ingalls, Cimarron, Howell, Dodge City, Ridgway, Spearsville, Offered, Bellefont and Kinsley, and to the Atchison, Topeka & Santa Fé Railway for its stations at those towns; also for providing water for irrigating a district in Southwestern Kansas, embracing an area of more than 800,000 acres. The works were completed and opened in March, 1887, at a cost of over $1,800,000. The main canal of the irrigation works is 95 miles in length, 45 ft. in width, and 6 ft. in depth, with 15 miles of branch canals. There are 40 reservoirs at intervals along the canal, covering an area of from 5 to 40 acres each. The trustees of the company in England are Mr. EDWIN GOODHUGH FOX, of the Grand Junction Water-Works Co.; Sir H. E. KNIGHT, of the Southwark & Vauxhall Water Co.; Mr. JOHN MILLS, of the New River Co., and Mr. H. G. HE NORMAN, of the Lambeth Water-Works Co.

Water-Works.—*Maine.*—Boothbay. The town has voted to contract with a Philadelphia firm for a water supply at $2,000 per year for 25 years.—Portland. Work on the Munjoy Hill reservoir will be resumed May 1.

Massachusetts.—North Brookfield. An appropriation of $1,200 has been made toward the construction of two new reservoirs.——Gloucester. At the annual meeting of the Gloucester Water Supply Co, on April 9, J. O PROCTOR was elected President; J. MCCUSKER, Superintendent; G. NORMAN WEAVER, Engineer and Treasurer; DAVID W. LOW, Clerk.——Greenfield. The Leyden reservoir is being cleaned out.——Marblehead. The contract for building the water-works has been let to T. Wm. Harris & Co., of New York. There will be about 8 miles of pipe. The work includes a large amount of difficult ledge work, as the streets are narrow and the ledge is hard.

Connecticut.—Portland. The town has voted to lay a system of water-works to supply the upper and lower villages. Messrs. Wheeler & Park, of Boston, are to have $2,100 a year for 20 years without being taxed, to put in the pipes and 70 hydrants.

New York.—Brockport. Buffalo parties are proposing to build water-works.——Clyde. The water company is preparing to lay its pipes under the canal.——Buffalo. The Comptroller will open the bids to-day for the issue of $225,000 3½ per cent. water-bonds. The first half of the total amount of $450,000 was issued in June, 1888. Bids for the new receiving and distributing reservoir will be opened by the Water Commissioners on May 21; it will cover 22 acres, and have a capacity of 125,000,000 galls.——Southampton. The town authorities have been petitioned to establish water-works, taking the supply from springs and lakes on the hills. The matter will be considered April 26.——Spring Valley. The water supply question has been agitated and surveys and plans have been prepared by W. C. FOSTER, of New York City, but at present the prospects are not very favorable.——Gloversville. Work will soon be commenced on the water-works. CHAS. C. HOPKINS, of Rome, is the engineer.

New Jersey.—Red Bank. By a recent act of the Legislature the town has been greatly enlarged, and therefore the present water supply is considered inadequate. The water bonds of the town now amount to $80,000, and it is thought that $25,000 additional will supply the increased demand. The Water Commissioners applied to the Board of Town Commissioners for this additional amount of bonds, and the board thought it best to let the people decide the question. They therefore ordered that an election be held on May 6.

Delaware.—Wilmington. Proposals will be received by the Water Department until April 30, for 4 filters with a daily capacity of 500,000 galls. each, at the City Mill pumping station; and a high-duty, compound, surface-condensing pumping engine of 2,500,000 galls. daily capacity at the Cool Spring station; it will force 130 ft. vertical in a distance of ¾ miles. For particulars address J. A. BOND, Chief Engineer.

Pennsylvania.—Bethlehem. The new water-works plant has been completed; the new tank will be 80 ft. in diameter. The work is in charge of the Water Department.——Philadelphia. Director WAGNER, of the Department of Public Works, has let contracts for pipe to the Mellert Foundry & Machine Co., of Reading, Pa., and D. L. Dawson, of Philadelphia; for trenching, to C. B. Walker.

Maryland.—Woodberry. The citizens have applied to the Baltimore Water Board for an extension of the mains to this place.

Virginia.—Hampton. The Hampton Water Co. has been organized to supply Hampton, Old Point Comfort, and other places in the vicinity. President, C. T. HOLTZCLAW; Treasurer, J. A. WATKINS; Secretary, H. R. BOOKER.

West Virginia.—Morganton. The Union Improvement Co. will order pipe for water-works very soon.

Florida.—Pensacola. The water company has contracted to furnish water for flush-tanks for 1 year.

Alabama.—Decatur. Connection from the Tennessee river to the pump-house of the water-works has been made, and upon the completion of the pump-house and the laying of the mains to the tower, the water system of Decatur and New Decatur, costing over $400,000, with 38 miles of pipe, will be ready for operation.——Fort Payne. The Fort Payne Coal & Iron Co. is interested in a water-works project.——Birmingham. The East Lake Land Co. will build water-works at the suburb of East Lake.——Anniston. Proposals will be received by J. H. TURNER, C. E., of Mobile, for the following supplies for the Anniston water-works, the franchise for which is owned by T. G. BUSH, of Mobile: 2 compound, condensing, duplex pumping engines of 3,000,000 galls. daily capacity; horizontal tubular boilers; 36,000 ft. of 20-in. pipe, 6,200 ft. of 16-in., 16,380 ft. of 12-in., 2,806 ft. of 8-in., 33,058 ft. of 6-in., and 1,200 ft. of 4-in.; 10 tons of special castings, 48 valves, 100 double-nozzle hydrants; also lead, marling, pipe laying, etc.

Mississippi.—Greenville. On April 9 the City Council awarded the contract for supplying the city with water for 30 years to the recently organized Delta Water-Works Co. The city takes 100 hydrants at a cost of $40 per year per hydrant, all subsequent hydrants to be $50 each. The company is also exempt from city taxation for ten years.

Louisiana.—New Orleans. The case between the city and the water company has been opened in the Supreme Court.

Tennessee.—Nashville. The contract for 20 hydrants and 14 valves has been awarded to R. D. Wood & Co., of Philadelphia, Pa.——Memphis. The sale of the Memphis water-works to the Artesian Water-Works Co. has been consummated, with the approval of the City Council. The former works were under a 50-year lease to the latter, but the stockholders in the latter decided to purchase in order to borrow several hundred thousand dollars in New York to complete their plant and connections.

Kentucky.—Winchester. The Winchester Water Co. has been organized by J. B. H. DAVENPORT, EPES RANDOLPH, and H. E. HUNTINGTON. Capital stock, $75,000.——Georgetown. Proposals for the construction of water-works and furnishing water for fire protection will be received until May 1 by S. M. DAVIS, Chairman of the Board of Trustees.

Ohio.—Marietta. The proposition has been carried to issue bonds for $100,000 for water-works.——Columbus. The Water-Works Trustees have received the following bids for the well to be constructed on the site of the new pumping station east of the city: James Westwater, Columbus, $18,000; Free & Meredith, Pittsburg, Pa., $16,220; John Owens and F. N. Saleger, Columbus, $22,500. The bid of the Pittsburg firm was accepted.

Indiana.—Washington. The $50,000 water bonds were taken by Woodbury & Moulton, of Portland, Me., who are now offering them for sale. The works are completed and accepted. The franchise is for 25 years.

Michigan.—Pontiac.—The water-works are completed.——Ypsilanti. At a special meeting of the Common Council April 9, ALD. GEORGE offered a resolution that the question as to whether the city shall be bonded in a sum not to exceed $75,000, and at a rate of interest not exceeding 4 per cent., for the purpose of establishing and maintaining a system of water-works, be submitted to a vote at a special election May 6. This was carried, as was also an ordinance creating a Board of Water Commissioners, to consist of one member from each of the five wards. A special committee was appointed to arrange for a public meeting prior to May 6, to discuss the question.

Illinois.—Lexington. The city has voted to issue $10,000 in 6 per cent. 20 year bonds for water-works.

Nebraska.—Madison. Water-works are being built at a cost of $18,000.——Lincoln. The Board of Public Works will receive bids until April 29 for sinking a wrought-iron caisson 5 ft. diameter to shut off the flow of salt water in the F. St. well.——Valentine. The new works will be completed by June. The supply is piped from the Minnechaduza river to a tank of 1,600 lbs. capacity; there are 9 double-nozzle hydrants. Bonds for $8,400 have been issued.——Ainsworth. Water-works are projected; the supply will probably be taken from driven wells.——O'Neill. The water-works are nearly completed.

Texas.—Childress. It is proposed to obtain a water supply from artesian wells.——Houston. The water company will sink another well; the new one, 154 ft. deep, has had a dynamite charge fired at the bottom to increase the supply.——Paris. The water question is under discussion.

New Mexico.—Raton. The water company will not put in any more hydrants until the town is incorporated.

Oregon.—Portland. Superintendent SMITH has presented the following estimates of cost for the reservoir in the city park: 20,000,000 galls., $86,600; 25,000,000 galls., $105,350; 30,000,000 galls., $124,100.

Washington Territory.—Coupeville. A small pumping engine has been put in to force the water from the spring above town to the tank.

California.—Felton. The Felton Water Co. has been organized by W. RUSSELL, J. I. SCOTT, W. B. DREW, and others. Capital stock, $10,000.—— San Francisco. The Spring Valley Water Co. has declared a dividend of 1 per cent. upon the $10,000,000 capital stock.

Canada.—Stratford, Ont. The Stratford Water Supply Co. has declined the city's offer of $3,000 for a year's water supply, and the sum will probably be settled by arbitration.——Boucherville, Que. The village will grant exclusive rights for 25 years to any person or company who will establish water-works. Annual revenue, $700 to $800. Address the Mayor, or M. DAMASE PARIZEAU, corner Craig and St. Denis Sts., Montreal.——Lachine, Que. The contractors for the water-works are Messrs. Lamontagne & Co., Montreal, under the direction of Mr. J. EMILE VANIER, C. E. Operations are rapidly advancing and they have arrived at the most difficult portion, the laying of the main across the canal. This double pipe will be sunk 5 ft. below the bottom of the canal, and at a point where the latter consists of solid limestone rock; 1,000 cu. yds. of this rock will have to be excavated.